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RELATIONSHIP OF WASTEWATER DISPOSAL PRACTICES ON DEVELOPMENT DENSITY OF EMERALD ISLE, NORTH CAROLINA

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Prepared For: Mayor and Board of Commissioners
Town of Emerald Isle, North Carolina

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Special gratitude is expressed to the Soil Capacity, Density and Sewage Disposal Study Committee composed of citizens of Emerald Isle for their input and guidance throughout the course of this study effort.

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Emerald Isle, North Carolina

SECTION 1: INTRODUCTION

1.1 Background

The Town of Emerald Isle is located on the western end of Bogue Banks, one of North Carolina's most attractive privately owned barrier islands. The Town has a land area of approximately 3,000 acres and occupies eleven miles of ocean frontage. Since 1962, when ferry service was established to the western end of the island, the Town has experienced a high rate of growth and development. This growth revolves around the attractiveness and desireability of the area for permanent homes and vacation homes. The annual growth rate between 1960 and 1970 was 64.3 percent and between 1970 and 1980 it was 50.8 percent. In recent years, much of this growth and development has been attributed to construction of a permanent, high level bridge near the west end of the island and multifamily housing projects (condominiums). This rapid growth has concerned local citizens.

In response to citizen concerns, the Town Board of Commissioners declared a moritorium on multiunit projects on May 12, 1981. This moritorium was subsequently lifted on September 8, 1981 following a decision to limit multiunit density from 13.5 units per acre to 10 units per acre. Since that action, several very large multiunit condominium projects were permitted and constructed which stimulated additional concerns related to wastewater disposal, water supply, fire protection, etc. As a result, on June 8, 1982 the Town Board imposed a second 90-day

moritorium on multi-family housing projects in order to study and define the problems and to propose workable solutions to the problems. This second moritorium was subsequently lifted on September 8, 1982. Press coverage of these later actions is displayed in Appendix A.

1.2 Scope of Work

The purpose of this study is to define the relationship of wastewater disposal practices on the development density of Emerald Isle. The study involves the definition of the specific areas where soil conditions, zoning regulations, and state and local regulatory requirements will permit the use of septic tanks and/or other suitable on-lot wastewater treatment and disposal systems. The maximum development densities which will be allowed for use of septic tanks and other on-lot systems will be defined where such systems might be employed. This study will also identify those areas which should be served by a central sewer system due to unsatisfactory soil conditions and projected growth and development trends associated with multi-unit condominium projects.

Also included in the scope of work will be the formulation of guidelines for future growth and development in terms of land use planning affected by suitable wastewater treatment and disposal modes. These guidelines also include the development of policies for construction of sewer systems and wastewater treatment systems by private developers. Such policies will be designed to insure compatibility with any future central sewer system and to provide a uniform standard for construction of such systems.

SECTION 2: EXISTING CONDITIONS

2.1 Approved Land Use Plan and Existing Pattern of Development

The Town of Emerald Isle has an approved and updated land use plan which was produced under the guidelines of the Coastal Zone Management Act of 1972.1./ The existing pattern of development consists primarily of single family homes along with an admixture of mobile homes, multifamily developments (condominiums), commercial uses and institutional use. Other major land uses consist of a large campground, a fishing pier and a marina/boat basin. According to the 1980 census, the Town of Emerald Isle has 2,400 dwelling units. However, only about 345 homes are occupied year-round (this is based on an assumed occupancy rate of 2.5 persons per unit and a 1980 census of 865 permanent residents). In the summer, when these units are occupied at an estimated rate of 3.5 persons per unit, the peak summer population for 1980 was estimated at 8,400 persons. The existing pattern of development is reflected in the Land Use Map (see Map 2.1).

According to the 1982 update of the Land Use Plan, the Town consists of 2,964 acres. Commercial land use totals 123 acres; institutional, 3 acres; and residential, 1,240 acres with 1,598 acres still undeveloped.

2.2 Zoning

The Town of Emerald Isle has an existing zoning ordinance which was adopted on 14 June, 1975. It has been amended and updated as required. The existing zoning districts and purposes

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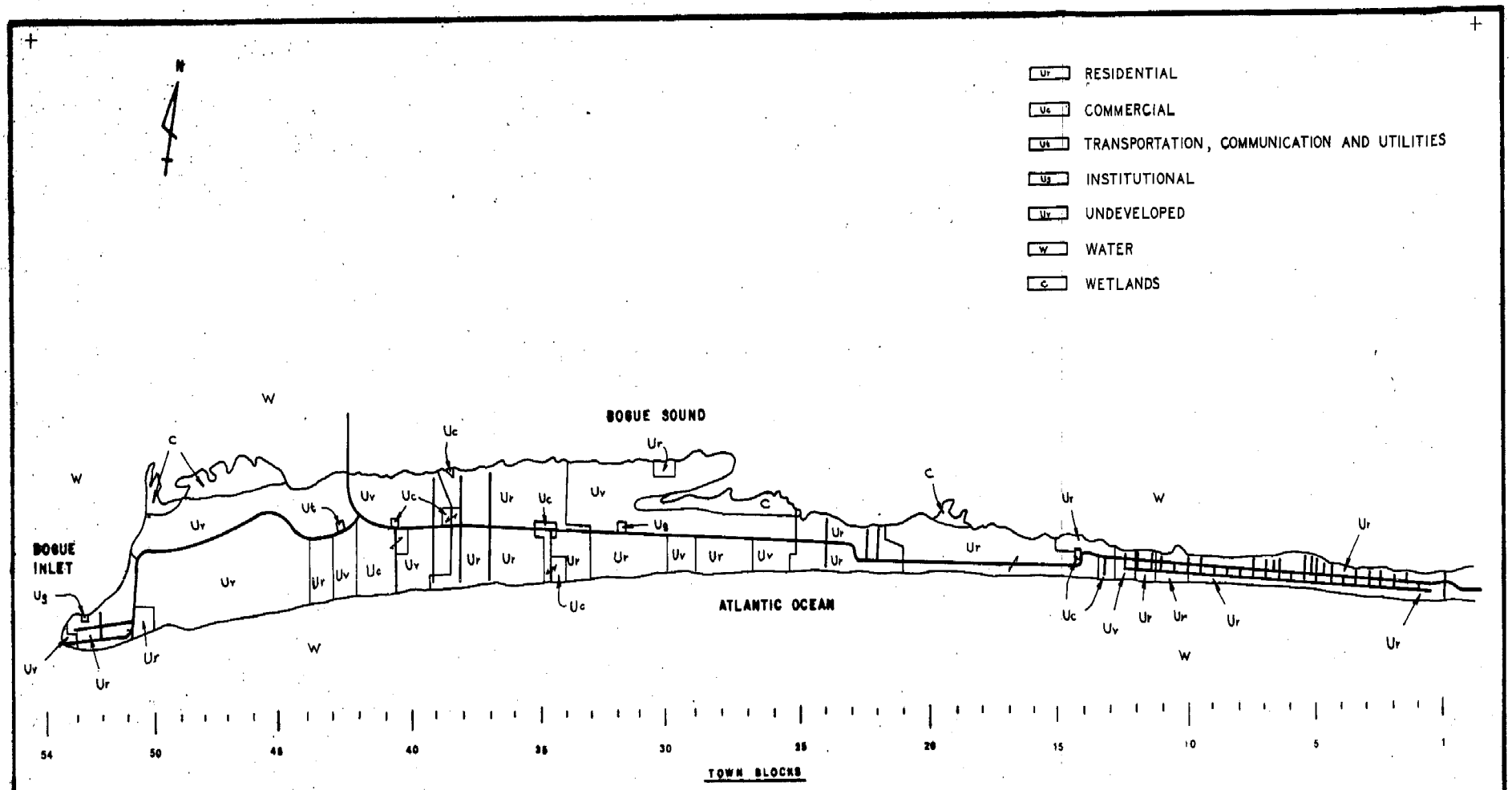
1./ Coastal Area Management Act Land Use Plan (May, 1976; amended February 12, 1977; updated August, 1981), Town of Emerald Isle. Prepared with the assistance of Dexter G. Moore, Moore and Associates, Urban Planners, Rocky Mount, N.C.

MAP 2.1

EXISTING LAND USE PATTERNS



TOWN OF EMERALD ISLE

0 2000 4000 6000

SCALE IN FEET

JUNE 1981

MAP 2.1
EXISTING LAND USE

MAP COURTESY OF:
DEXTER MOORE and ASSOCIATES

are shown in Table 2.1. Multi-family dwellings are permissible in the RMF, INT and RMH zones at a density of up to 10 units per acre. Of special concern is the fact that some 1,400 acres of land is zoned for multifamily/condominium uses. With a current density of 10 dwelling units per acre allowed in the zoning ordinance, this area will accommodate 14,000 dwelling units if fully developed. Based on an overall average of 3.5 persons per unit, a total buildout of these areas alone could accommodate a peak seasonal population of some 49,000 persons. Assuming a wastewater loading of 70 gallons per capita per day, a seasonal peak sewage flow from this area of development could amount to 3.43 million gallons per day.

When the other zoning categories are included in a projection of a total potential buildout of the Town, the potential quantity of wastewater becomes more significant. If of the total of 2,964 acres of developable land 1,400 acres are zoned for multifamily use, then about 1,564 acres are developable under the other zoning categories. If an average lot size of 12,500 square feet is assumed, then a total of 5,500 dwelling unit lots is possible. Based on an average of 3.5 persons per unit, these areas can accommodate about 19,250 persons. At 70 gal/cap/day, a total peak seasonal sewage flow of 1.25 MGD is possible from development associated with these other zoning categories.

Therefore, a total sewage flow of 4.78 MGD is possible at total buildout under existing regulations. This flow would represent a significant impact on the environment.

TABLE 2.1
ZONING DISTRICTS/PURPOSES
TOWN OF EMERALD ISLE

Districts	Purpose
Residential 1 (R1)	A single family residential district allowing a single family dwelling on a lot.
Residential 2 (R2)	A residential district allowing a single family dwelling, or a two family dwelling on a lot.
Residential MF (RMF)	A residential district allowing a single family dwelling, a two family dwelling, or a multifamily dwelling on a lot.
Residential MH (RMH)	A residential district allowing a single family dwelling, a two family dwelling, a multifamily dwelling, a motel or hotel on a lot.
Mobile Home (MH)	A moblie home district allowing mobile homes.
Institutional (Inst.)	A residential district allowing institutional and office uses, not including the sale of merchandise.
Commercial (Com.)	A commercial district allowing retail trade.
Camp (C)	A recreational district allowing travel trailers, campers and tents.
Coastal Wetlands (CW)	An overlay district which may overlay any of the zoning districts so established as a part of this Ordinance, requiring that development within such districts be consistent with the Coastal Wetlands standards of the North Carolina Coastal Area Management Act of 1974 as amended. (Adopted March 10, 1979).
Estuarine Waters (EW)	An overlay district which may overlay any of the zoning districts so established as a part of this Ordinance, requiring that development within such districts be consistent with the Estuarine Waters standards of the North Carolina Coastal Area Management Act of 1974 as amended. (Adpoted March 10, 1979.)

Table 2.1, Continued

Districts	Purpose
Public Trust Areas (PTA)	An overlay district which may overlay any of the zoning districts so established as a part of this Ordinance, requiring that development within such districts be consistent with the Public Trust standards of the North Carolina Coastal Area Management Act of 1974 as amended. (Adopted March 10, 1979).
Ocean Beaches (OB)	An overlay district which may overlay any of the zoning districts so established as a part of this Ordinance, requiring that development within such districts be consistent with the Ocean Beaches standards of the North Carolina Coastal Area Management Act of 1974 as amended. (Adpoted March 10, 1979.)
Frontal Dunes (FD) (PTA)	An overlay district which may overlay any of the zoning districts so established as a part of this Ordinance, requiring that development within such districts be consistent with the Fontal Dunes standards of the North Carolina Coastal Area Management Act of 1974 as amended. (Adopted March 10, 1979).
Inlet Lands (IL)	An overlay district which may overlay any of the zoning districts so established as a part of this Ordinance, requiring that development within such districts be consistent with the Inlet Lands standards of the North Carolina Coastal Area Management Act of 1974 as amended. (Adpoted March 10, 1979.)
Ocean Erodible Areas (OEA)	An overlay district which may overlay any of the zoning districts so established as a part of this Ordinance, requiring that development within such districts be consistent with the Ocean Erodible Areas standards of the North Carolina Coastal Area Management Act of 1974 as amended. (Adopted March 10, 1979).

Another alternative would be to rezone these 1,400 acres now available for multifamily development to R-1 or R-2. Assuming a zoning split of 50/50 for R-1/R-2 this would create 700 acres zoned R-1 and 700 acres zoned R-2. Further assuming a density of 3 units per acre for R-1 and 6 units per acre for R-2 (vertical duplexes) a total of 2,100 dwelling units would be possible in the R-1 area and 4,200 units would be possible in the R-2 area for a total of 6,300 dwelling units if fully developed. Based on an overall average of 3.5 persons per unit, a total buildout of these areas could accomodate a peak seasonal population of some 22,050 persons. Assuming a wastewater loading of 70 gallons per capita per day, a seasonal peak sewage flow from this area of development could amount to 1,543,500 gallons per day.

When this potential flow is added to the projected flow from other zoning categories as developed above (1.25 MGD), a total sewage flow of 2.79 MGD is possible at total buildout under a regime of modified zoning. This flow would be less than that anticipated from a development mode based on existing zoning, but it still would represent a significant impact on the environment.

It should be clearly pointed out that a change in zoning problems will not preclude the need for a central sewer system. In fact, it could accelerate the need for a central sewer system by virtue of the fact that a change in zoning from multifamily use to single family or duplex uses will also increase the use of septic tanks for sewage disposal. Multifamily developments will most likely use package wastewater treatment systems while single family or duplex developments will normally use septic tanks for wastewater disposal.

2.3 Existing Wastewater Treatment Systems

Wastewater treatment and disposal for single family homes is accommodated by means of septic tanks and gravity fed drain fields. Some problems with existing septic tanks have been identified by the Carteret County Sanitarian (see letter, Appendix B). The wastewater from the multiunit condominium developments is treated by package wastewater treatment facilities and is disposed of by subsurface drain fields or by means of rotary distributors. Table 2.2 presents a listing of existing package treatment facilities at Emerald Isle. Once all of these wastewater treatment facilities are operated at their rated capacity, there is a potential for discharge of 295,500 gpd of treated effluent to the groundwater aquifer at Emerald Isle.

TABLE 2.2

EXISTING (AND PROPOSED) PACKAGE WASTEWATER TREATMENT FACILITIES SERVING MULTIUNIT HOUSING PROJECTS[1./]

	Project/Development Name	Total # Units	Location	Sizing of Treatment Facility (GPD)[2./]	Degree of Treatment	Mode of Effluent Disposal	Project Status
1.	Point Emerald Villas	177	Coast Guard Road	28,000 GPD	Tertiary	Rotary Distributors	Some units built and occupied
2.	Beachwood Campground	430 Sites	Coast Guard Road	75,000 GPD	Tertiary	Rotary Distributors	Under construction
3.	Pebble Beach Condominiums	228	Coast Guard Road	70,000 GPD	Tertiary	Rotary Distributors	Under construction
4.	Sea Oats	96	Reed Drive	26,500 GPD	Tertiary	Rotary Distributors	Proposed. Local approval pending.
5.	Sound of the Sea Townhouses	154	Reed Drive	56,000 GPD	Tertiary	Subsurface Disposal and Rotary Distributors	17 units complete
6.	Seafield One, Ltd.	96	Emerald Drive	40,000 GPD	Tertiary	Tertiary Subsurface Disposal	Proposed/ Approved
	Total Potential Peak Seasonal Sewage Flow			295,500 GPD			

NOTES:

1./ Source: Based on data on file in Southeastern Regional Field Office of NCDEM, Wilmington.

2./ Some treatment facilities are to be built in stages and, therefore, are sized to accomodate only a portion of the ultimate flow from the development.

SECTION 3: FUTURE GROWTH AND DEVELOPMENT

3.1 Future Growth Projections

Future growth projections for Emerald Isle are found in the Land Use Plan. Table 3.1 presents the estimated future population for the two major segments of the local population, permanent residents and peak summer (seasonal) residents.

As indicated in the Land Use Plan, the summer population is growing at a much faster rate than the permanent population. There were 2,400 dwelling units in Emerald Isle in 1980 according to census data. The projections shown in Table 3.1 are based on an average of 3.5 persons per dwelling unit. So, by the year 2000 some 3,857 to 4,429 dwelling units are projected for Emerald Isle.

Projections of future land acreage needs with and without a central sewer system were also made in the Land Use Plan. The projections are shown in Table 3.2. As indicated in the Land Use Plan, when a central sewage system is installed, zoning density standards will be used in lieu of septic tank space requirements and acreage needs will be reduced substantially. It should be pointed out that the projections shown in Table 3.2 are not necessarily inconsistent with the total potential buildout of the Town at some unknown time in the future (see Section 2.2 above).

TABLE 3.1

ESTIMATED FUTURE POPULATION[1./]
TOWN OF EMERALD ISLE
(1970 - 2000)

Year	Permanent Residents	Peak Seasonal Residents[2./]
1970	122	NA[3./]
1975	230	5,300
1980	865	8,400
1985	1,200 - 1,400	9,500 - 10,500
1990	1,500 - 1,900	10,500 - 12,500
2000	2,200 - 2,800	13,500 - 15,500

1./ Source: 1981 CAMA Land Use Plan Update.

2./ Includes both permanent and seasonal (summer) residents. Day visitors are not included in these projections.

3./ Information not available.

TABLE 3.2

FUTURE LAND ACREAGE NEEDS[1./]
WITH AND WITHOUT A CENTRAL SEWER SYSTEM FOR THE
TOWN OF EMERALD ISLE

	Without Central Sewer System		With Central Sewer System	
Year	Commercial[2./]	Residential[3./]	Commercial[2./]	Residential[3./]
1975	26	901	26	801
1985	100	1,594	100	923
1995	135	2,386	135	1,043
2005	140[4./]	2,824	140	1,164

Notes:

1./ Source: 1981 CAMA Land Use Plan Update.

2./ Projections based on 0.01 acre per person.

3./ Projections based on current developed densities.

4./ Represents fully developed state for this land use category.

SECTION 4: WASTEWATER PRACTICES AND ALTERNATIVES

4.1 Septic Tanks[1./]

Much has been written and said recently about septic tanks and their use in the coastal zone of North Carolina. Opinions concerning their suitability have ranged from total acceptance to unacceptability under any circumstances. Despite the wide range of popular opinions on the subject, septic tanks are a recognized and acceptable means of wastewater treatment and disposal if properly designed, installed under acceptable conditions and operated properly. Permits for the installation of septic tank systems are issued by the Carteret County Health Department, Environmental Health Section under guidelines issued by the N.C. Department of Human Resources, Division of Health Services, Environmental Health Section, Raleigh, NC. The primary factors that govern the overall acceptability of this method of wastewater treatment include soil suitability and types, depth to the groundwater table, proximity to surface waters and density of development. Each of these factors are considered in greater detail below:

4.1.1 Soil Suitability and Types

Proper performance of septic tank absorption fields depends in part on the ability of the soil to absorb the wastewater. Failure occurs if this function is not performed. Absorption is directly related to the hydraulic conductivity characteristics of

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1./ Unless otherwise indicated, it is assumed for the purposes of this report that the use of the term "septic tank" implies the conventional septic tank with a gravity fed soil absorption drain (nitrification) field.

the soil, which are largely controlled by the pore geometry (texture) of the soil material. The general pattern of soil types at Emerald Isle are shown on Map 4.1. Descriptions of each of the soil types using USDA Soil Conservation Service (SCS) classification system are found in Appendix C.

Map 4.2 (located in Map Pocket) presents a graphic representation of the overall soil patterns at Emerald Isle in terms of septic tank limitations. The limitations, whether severe or very severe, are based on Soil Conservation Service criteria. In many of the soils that have severe limitations for septic tank absorption fields, it may be possible to install special alternative systems (see Section 4.1.4) so that satisfactory performance can be achieved. However, suitablility decisions can only be made on a case by case and lot by lot basis. Generally speaking, soils that have very severe limitations are unsuitable for septic tank systems of any nature.

Map 4.2 also clearly shows that large areas along the sound side of the island have severe or very severe limitations for septic tank use. The map also clearly shows several pronounced linear, interdunal narrow troughs that contain either ponded water, shallow organic soils, or poorly drained mineral soils. These areas are not easily drained and filled, and consequently, would require extensive modifications to be classed as suitable for ground absorption systems (see Appendix B). The linearity of, or "barrier" created by these unsatisfactory soil patterns could represent potential pollution problems by septic tank systems in adjacent areas classified "satisfactory" by concentrating or trapping the effluent migration from these

MAP 4.1

SOIL TYPES

MAP 4.2

SEPTIC TANK LIMITATIONS

systems in those low lying, unsatisfactory soils areas. A system of sewer lines to a central system "bridging" these unsatisfactory soils areas could adequately service all of the properties in the area regardless of soils classification.

It should be clearly indicated that the scale of Map 4.2 precludes the display of all of the actual interdunal troughs at Emerald Isle. The map is a useful general guide for broad planning purposes. However, it is not suitable for detailed planning of individual tracts of land. Suitability of a specific site must be determined by an on site survey by a soils specialist. Even areas displayed as suitable on this map may contain zones which are actually unsuitable.

4.1.2 Depth to Groundwater Table

To insure adequate purification of the wastewater before it reaches the ground water, unsaturated soil is necessary below the drain field piping. The amount of unsaturated soil required for adequate wastewater renovation varies from 1 to 3 feet. If saturated soils occur within this zone of renovation, transmission of harmful pollutants to the ground water may result. If the zone of saturation should rise above the drain field, septic tank effluent could reach the ground surface and cause ponding and/or surface run-off of the effluent with attendant potential public health problems.

The results of a recent study conducted by investigators of N.C. State University Department of Soil Science[1./] indicate that

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1./ Carlile, B.L., C.G. Cogger, Sobsey, M.D., Scandura, J., and Steinbeck, S.J. October, 1981. Movement and Fate of Septic Tank Effluent In Soils of the North Carolina Coastal Plain. Sanitation Branch, N.C. Division of Health Services, Raleigh, N.C.

the location of the groundwater table is the most important factor affecting the movement and treatment of septic tank effluents. Fifteen of the 17 systems studied were at least seasonally saturated. Those systems which were nearly continually saturated had the highest concentration of contaminants in the ground water, and the contaminants moved the farthest. System design and maintenance and soil texture were also contributing factors.

Contamination was generally confined to within 25 feet of the systems, but more widespread movement was noted in several continuously saturated cases. Nitrogen was found primarily as ammonium around the more saturated systems and as nitrate around the better aerated ones. Phosphorus seldom moved more than 5 feet from the systems. Fecal coliform counts tended to be higher and more widespread around the wetter systems.

4.1.3 Proximity to Surface Waters and Density of Development

Statistical data gathered from several areas of coastal North Carolina[1./2./3./4./] have conclusively demonstrated that septic

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1./ USEPA, Surveillance and Analysis Division, May, 1975. Finger-Fill Canal Studies, Florida and North Carolina. EPA Publication No. 904/9-76-017, Athens, GA.

2./ USEPA, Surveillance and Analysis Division, July, 1975. Waste Source and Water Quality Studies, Surf City, North Carolina and Vicinity, EPA, Athens, GA.

3./ NCDEM, Groundwater Section, April, 1978. The Influence of the Water Table Aquifer on Shellfish Waters Near Surf City and Old Settler's Beach, Pender and Onslow Counties, N. C. Report of Investigation No. 12, Raleigh, NC.

4./ NCDEM, February, 1982. The Impact of Septic Tanks on Shellfish Waters, Raleigh, NC.

tank systems can pollute the groundwater and adjacent estuarine areas. During periods of heavy rains, partially treated effluent from septic tanks may break to the surface and pond in low areas. Effluent may also migrate to adjacent surface waters. Elevated coliform densities and low levels of dissolved oxygen may be found in finger fill canals which are densely developed.

It is pertinent to this study to make special note of a recent study[4./] completed by the North Carolina Division of Environmental Management, with the support of the Shellfish Sanitation Unit of the Department of Human Resources. This study involved an investigation of bacterial contamination of shellfish waters in four tidal creeks which drain to the Atlantic Intracoastal Waterway (AIWW) in New Hanover County. Fecal and total coliform bacterial indicators were monitored at twenty-two sampling locations during both wet and dry weather. The resulting bacteriological quality of the tidal estuaries and their tributary freshwater creeks was compared to the different densities of unsewered residences in each watershed and the limitations of the developed soils for assimilating septic tank effluent. The results of the data analyses indicated that as higher concentrations of septic tanks are installed in coastal watersheds, greater levels of fecal and total coliform bacteria are recorded during both wet and dry weather. These higher levels of bacterial contamination have resulted in violations of water quality standards in several North Carolina estuaries.

4./ NCDEM, February, 1982. The Impact of Septic Tanks on Shellfish Waters, Raleigh, NC.

(Clearly other activities associated with development, including land clearing activities, increased runoff from impervious areas, and contamination from domestic animals and birds, also contribute to the closure of shellfish waters.) However, since high bacterial densities were recorded during dry weather, and since seepage of septic tank effluent into ditches was observed, much of the contamination may be attributed to septic tank systems sited in unsuitable soils rather than surface runoff from developed or "disturbed" land. The majority of development in the NCDEM study areas occured on soils classified by the Soil Conservation Service as having severe limitations for septic tank use. Of the four tidal watersheds examined, the partially developed watershed, with an estimated septic tank density of less than one drainfield every seven acres, had acceptable water quality and was open to shellfishing. Two watersheds with estimated densities greater than one drainfield per four acres were contaminated by bacteria and closed to shellfishing. Contamination of estuarine waters should be expected when dense development using conventional septic tanks occurs on unsuitable soils, the study concluded.

4.1.4 Modifications to Septic Tank Systems to Improve Acceptability

The design of septic tank systems can be modified to permit the method to be used in cases where soils are unsatisfactory for a conventional installation. The primary modifications are (1) duplex drain fields, (2) low pressure distribution systems and (3) mound systems.

These modifications to conventional septic tank systems have been extensively studied by investigators at the NCSU Soil Science Department, Raleigh, N.C. and others. The information in the following sections is based in part on the more detailed information found in the following investigative reports:

(1) Craig Cogger, Bobby L. Carlile, Dennis Osborne and Edward A. Holland, May, 1982. Design and Installation of Low-Pressure Pipe Waste Treatment Systems. UNC Sea Grant College Publication UNC-SG-82-03.

(2) Craig Cogger, Bobby L. Carlile, Dennis Osborne and Edward A. Holland, August, 1982. Design and Installation of Mound Systems for Waste Treatment. UNC Sea Grant College Publication UNC-SG-82-04.

(3) USEPA. October 1980. Design Manual. Onsite Wastewater Treatment and Disposal Systems. Office of Research and Development, MERL, Cincinnati, Ohio.

4.1.4.1 Duplex Drain Fields

In this case, duplex gravity fed drain fields are constructed to permit the diversion of the wastewater flow from one soil absorption area to another to provide long-term alternate resting periods. Flow diversion may be accomplished by the use of commercially available diversion valves or by diversion boxes. Maintenance of diversion valves or boxes involves little more than turning the valve at the desired frequency to optimize the operation. The alternate resting periods for each field help to prevent the clogging of lines by sewage solids and/or biological

growths which is one primary cause of failures of such systems. This modification essentially doubles the area of a lot needed for wastewater disposal. Some of the smaller lots at Emerald Isle cannot accomodate duplex drain lines. Costs for those systems will obviously be higher than for conventional drain fields.

4.1.4.2 Low Pressure Distribution Systems

A soil-absorption system must serve two purposes: (1) keep untreated effluent below the surface, and (2) purify the effluent before it reaches the groundwater or surface waters. The system works best when the distribution area is not saturated with water or effluent, allowing efficient aerobic bacteria to treat the wastes.

There are several conditions which frequently hinder the operation of soil-absorption systems. Clogging of the soil can occur from localized overloading during use or from the mechanical sealing of the soil-trench interface during construction. This clogging can cause effluent to break through to the surface, especially in fine-textured soils. Anerobic conditions caused by continuous saturation due to overloading or a high-water table retard treatment, increasing the potential for pollution. Shallow soils are not deep enough to purify the effluent.

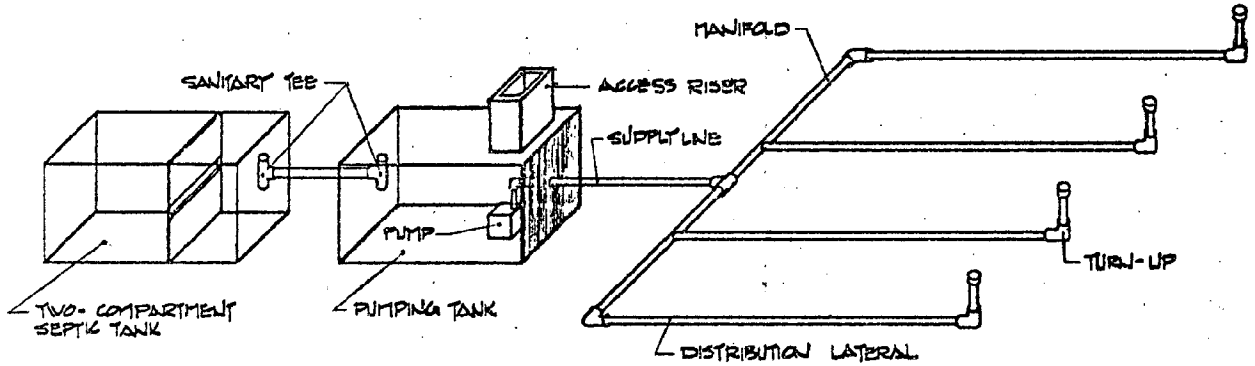
The low pressure pipe (LPP) system has three design improvements to help overcome these problems. These are:

- uniform distribution of effluent
- dosing and resting cycles
- shallow placement of trenches

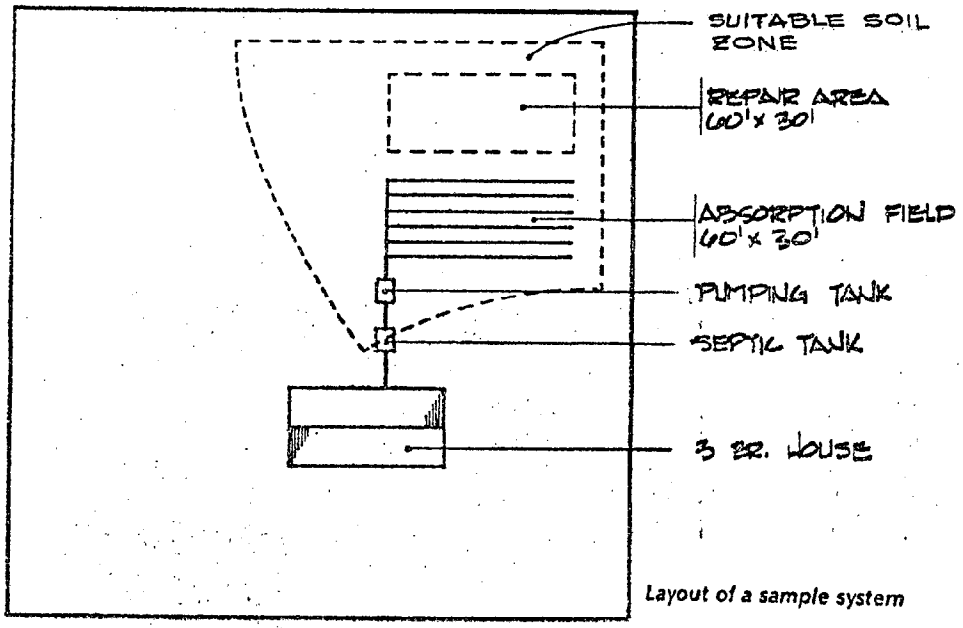
Problems from local overloading are deceased when effluent is distributed over the entire absorption area. Dosing and resting cycles help maintain aerobic conditions in the soil, improving treatment. Shallow placement increases the vertical separation from the system to any restrictive horizon or seasonally high-water table.

A low pressure pipe system is a shallow, pressure-dosed soil-absorption system. Figure 4.1 shows the basic components of and a typical layout of a low pressure pipe system. The distribution laterals are normally PVC pipes containing small holes (1/8 inch to 1/4 inch diameter) spaced three to five feet apart. The pipes are placed in narrow trenches six to 18 inches deep, spaced five or more feet apart. Under low pressure [0.7 to two pounds per square inch (psi)] supplied by the pump, septic tank effluent flows through the holes and into the trenches. It diffuses from the trenches into the soil where it is treated. The level controls in the dosing tank are set so that the effluent is pumped two to four times daily with resting periods in between to allow aerobic treatment of effluent.

The suitability of an LPP system for a given site is determined by the soil, slope and available space, as well as by the anticipated waste flow. Table 4.1 indicates the maximum loading rates for low pressure pipe systems based on soil texture and estimated permeability.



Basic components of a low pressure pipe system



Layout of a sample system

SOURCE: COGGER et al MAY, 1982 DESIGN AND INSTALLATION OF LOW PRESSURE PIPE WASTE TREATMENT SYSTEMS. UNC SEA GRANT COLLEGE PUBLICATION. UNC-SG-82-03, RALEIGH, N. C..

FIGURE 4.1
BASIC COMPONENTS OF AND TYPICAL LAYOUT OF A LOW PRESSURE PIPE SYSTEM.

TABLE 4.1

MAXIMUM LOADING RATES FOR LPP SYSTEMS

BASED ON SOIL TEXTURE AND ESTIMATED PERMEABILITY

USDA Soil Texture[1./]	Estimated Permeability (min/in.)	Maximum Loading Rate[2./] (gpd/ft^2)
Sand, loamy sand	20	0.50 - 0.40
Sandy loam, silt loam	20 - 40	0.40 - 0.30
Sandy clay loam, clay loam	40 - 60	0.30 - 0.20
Silty clay loam, sandy clay	60 - 90	0.20 - 0.10
Silty clay, clay	90 - 120	0.10 - 0.05

1./ This table does not consider the effects of clay permeability. A sandy clay composed of 1:1 clays may be more permeable than a clay loam of 2:1 clays.

2./ These loading rates should be used only for calculating the size of LPP systems - not for other types of systems.

The distribution network of most residential LPP systems occupies from 1,000 square feet to 5,000 square feet of area depending on the soil permeability and design waste load. In addition, an area of equal size must be set aside for future repair or replacement of the system. Space between the existing lateral lines is not a suitable repair area, unless the initial spacing between lines is 10 feet or wider. The septic tank, pumping chamber, distribution field and repair area are also all subject to horizontal setbacks from wells, property lines, building foundations, etc., as specified in local or state regulations. Although it is not feasible to integrate all of the site and soil setback criteria into a general lot size requirement, an undeveloped lot smaller than one acre will not usually be acceptable for an LPP system. Thus, this system has only limited applicability to Emerald Isle due to the high cost of land and small lot sizes (15,000 sq.ft. average).

An LPP system should be situated on the best soil and site on the lot. A minimum of 12 inches of suitable soils is required between the bottom of the absorption field trenches and any underlying restrictive horizons such as a hardpan, or to the seasonally high, water table. LPP trenches can be placed as shallowly as eight to 12 inches deep, giving a minimum soil-depth requirement of 20 to 24 inches. The soil must be of suitable or provisionally suitable texture, structure and permeability, as defined in state regulations. In some cases where the depth to the seasonal water table or restrictive horizons is less, a modified LPP may be installed using imported fill. Great care

must be used in building these systems.

Depressions, gullies, drains and erosional areas must be avoided to prevent hydraulic overloading by surface runoff. Neither the septic tank, pumping chamber nor distribution field should be located in such areas. Surface water and perched groundwater must be intercepted or diverted away from all components of the LPP system.

Installation costs for these systems is relatively high and operation and maintenance costs associated with the mechanical equipment must be anticipated.

4.1.4.3 Mound Systems

A mound system is a soil absorption system that is elevated above the natural soil surface in a suitable fill material. The purpose of the design is to overcome site restrictions that prohibit the use of conventional soil absorption systems. Such restrictions common to the coastal area are: (1) slowly permeable soils, (2) shallow permeable soils over a hardpan, and (3) permeable soils with high water tables. In slowly permeable soils, the mound serves to improve absorption of the effluent by utilizing the more permeable topsoil and eliminating construction in the wetter and more slowly permeable subsoil, where smearing and compaction are often unavoidable. In permeable soils with insufficient depth to groundwater or with the presence of a hardpan, the fill material in the mound provides the necessary treatment of the wastewater. A schematic diagram and typical cross section of a mound system are shown in

Figure 4.2. Typical loading rates are shown in Table 4.2.

The mound system consists of: (1) a suitable fill material, (2) an absorption area, (3) a distribution network, (4) a cap, and (5) topsoil. The effluent is pumped or siphoned into the absorption area through a distribution network located in the upper part of the coarse aggregate. It passes through the aggregate and infiltrates the fill material. Treatment of the wastewater occurs as it passes through the fill material and the unsaturated zone of the natural soil. The cap, usually a finer textured material than the fill, sheds precipitation and retains moisture for a good vegetative cover. The topsoil provides a growth medium for the vegetation.

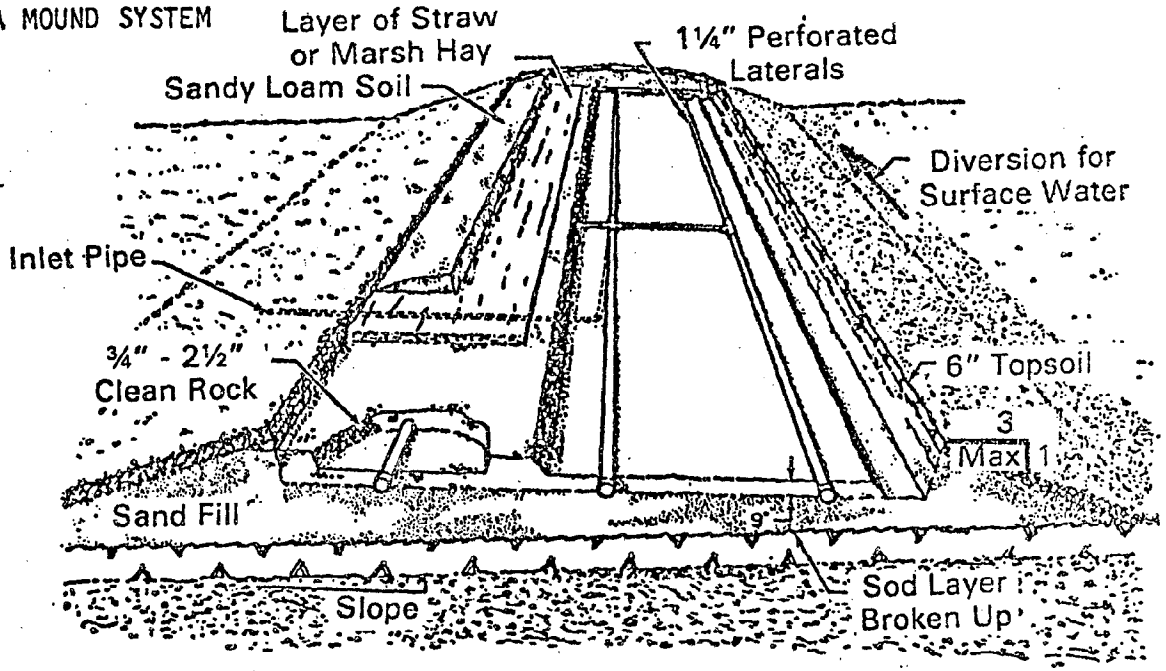
Mound systems typically require large land areas. Although it is not possible to integrate all the various site, soil and setback requirements into a general lot size requirement, undeveloped lots smaller than three quarters of an acre may not be acceptable for a mound system. Therefore, this method has limited applicability for Emerald Isle except in cases where two or more small lots can be combined. Installation costs for these systems are also high due to the need for mechanical equipment and the need to import suitable fill materials. A typical mound system will cost between $4,000 and $7,000.

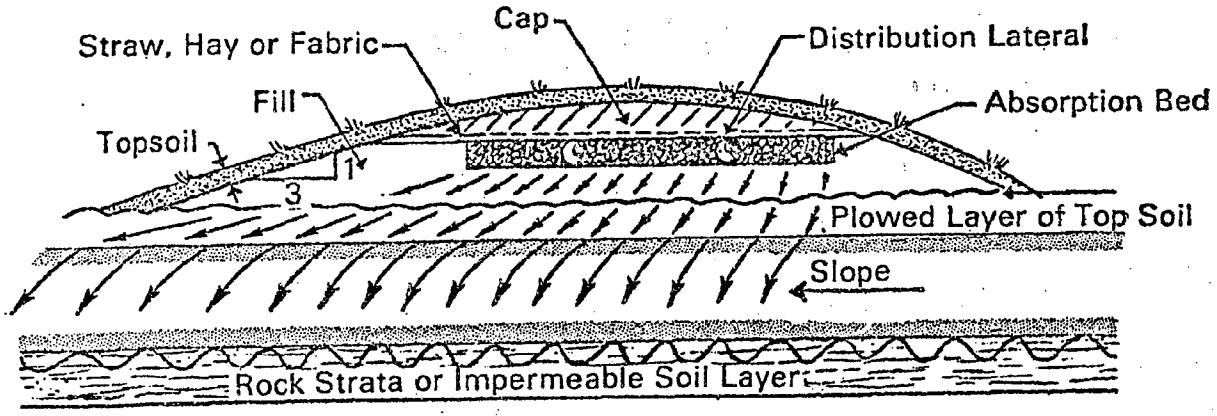
4.1.4.4 Summary, Septic Tank Systems

Septic tanks will probably continue to be used in some areas of Emerald Isle for some years to come. Applicability and acceptability must be judged on an individual case-by-case basis.

DETAILED SCHEMATIC OF A MOUND SYSTEM

SOURCE: USEPA - OCTOBER, 1980
DESIGN MANUAL - ONSITE WASTEWATER
TREATMENT AND DISPOSAL SYSTEMS.
CINCINNATI, OHIO.





Cross Section of a Mound System for Slowly Permeable Soil on a Sloping Site.

FIGURE 4.2
DETAILED SCHEMATIC AND CROSS SECTION OF A MOUND SYSTEM.

TABLE 4.2

INFILTRATION RATES FOR DETERMINING THE BASAL AREA OF A MOUND SYSTEM[1./]

Natural Soil Texture	Percolation Rate min/in.	Infiltration Rate gpd/ft
Sand, sandy loam	0 - 30	1.2
Loams, silt loams	31 - 45	0.75
Silt loams, silty clay loams	46 - 60	0.5
Clay loams, clay	61 - 120	0.25

1./ Source: USEPA. October, 1980. Design Manual, Onsite Wastewater Treatment and Disposal Systems. Cincinnati, Ohio.

For areas with unsuitable soils, certain modification to the standard septic tank system are possible, but the small lot sizes at Emerald Isle or the high costs associated with modified systems will normally preclude these. Also State regulations 1./ require sites to have sufficient available space to permit the installation and proper functioning of ground absorption sewage treatment and disposal systems along with sufficient available space for a possible future repair area equal to the original area. Individual lots including those in subdivisions, which on January 1, 1983, are described in a recorded deed or recorded plat and have inadequate space for repair, are exempted from this regulation. Also, individual lots including those in subdivisions, for which evidence of existence is a file with the local health department on July 1, 1982 (effective date of regulation), and have inadequate space for repairs, are also exempt from this rule. However, this exemption will expire on June 30, 1985. So for all lots subdivided after January 1, 1983, repair areas will be required. This regulation may prevent the development of some of the smaller lots at Emerald Isle until central sewers are provided. Costs for all of the modified type systems described above will be considerably higher than for conventional septic tank systems.

1./ N.C. Department of Human Resources, Division of Health Services, Environmental Health Section, July 1, 1982. Laws and Rules for Ground Absorption Sewage Treatment and Disposal Systems. Raleigh, N.C.

4.2 Package Wastewater Treatment Facilities

4.2.1 General

Package wastewater treatment facilities are prefabricated wastewater treatment units which have been used as "substitutes" for a central sewer system. Normally such units have been used to treat wastewater from multi-unit condominium projects hotels/motels and campgrounds. At Emerald Isle, State regulations prohibit direct discharges to surface waters (Bogue Sound), so all of these systems use some form of land disposal of treated effluent. State regulations also require tertiary treatment and disinfection prior to effluent disposal. Prior to the construction of such systems, approval in the form of a permit must be obtained from the N.C. Division of Environmental Management (NCDEM) or the N. C. Division of Health Services (NCDHS) through the Carteret County Health Department.

At the present time there are three main forms of effluent disposal used in the coastal area. These are:

- Land application by spray irrigation.
- Subsurface disposal by gravity fed or pressure fed drain fields.
- Land application by rotary distributors.

Permits for land application by spray irrigation or by rotary distributors are issued by NCDEM. Permits for subsurface disposal are issued by the Carteret County Department of Health, Environmental Health Section, acting in behalf of NCDHS.

Package wastewater treatment facilities can achieve high levels of removal of pollutants, if they are properly operated and maintained. However, their performance record has been traditionally less than satisfactory due to a lack of operation and maintenance. For example, a recent evaluation of the operation and maintenance of 20 extended aeration activated sludge package wastewater treatment facilities in Canada revealed that only four out of 20 (20 percent) produced effluents better than or comparable to the performance levels reported by the National Sanitation Foundation (NSF).1./ The majority of the plants did not achieve the anticipated performance objectives. The problems encountered in the package plant operation could be categorized into three groups, process, equipment, and operator-oriented problems. Those plants that produced substandard effluent quality were identified to be related to one or a combination of these problems. Process-oriented problems were mainly associated with insufficient biomass, improper aeration, floating sludge, offensive odors, and a lack of sludge treatment facilities. Equipment-oriented problems included mechanical breakdown of comminutors, clogging of air diffusers and sludge return systems and malfunction of the skimming device. However, the major cause of the poor performance of package plants was attributed to the operators' inability to operate and maintain facilities, because of insufficient manpower or lack of operator training.

1./ Guo, P.H.M. *etal* January, 1981. "Evaluation of Extended Aeration Activated Sludge Package Plants" Journal WPCF 53(1):33-42.

4.2.2 Land Application by Spray Irrigation

This method of effluent disposal requires large amounts of land due to the requirement for buffer zones, effluent storage during inclement weather, conservative spray application rates (on the order of 0.75 to 1.25 inches per week), and alternate spray irrigation areas to allow for soil rest periods. Due to the high cost of suitable land and the pressure to develop these more desireable tracts for residential use, it is unlikely that this method will receive wide use or any degree of acceptance for on-island waste disposal. However, large tracts of suitable land exist on the mainland which could be used for this method of disposal for a future municipal facility (see Section 4.4.2).

4.2.3 Subsurface Disposal by Gravity-Fed or Pressure Fed Drain Fields

Most of the older package plant systems have used this approach to wastewater disposal. Until recently, this method was regulated by NCDEM under the so called "Coastal Regulation" (Regulation 2-79). Under the former DEM guidelines, subsurface disposal facilities were normally designed on the basis of site conditions and soil percolation rates with loading rates not to exceed 1.5 gallons per square foot of trench bottom.1./ Using a trench width of 3 feet and an 8 foot center-to-center trench separation, this loading rate equated to a maximum potential loading of 24,570 gallons of treated effluent per acre. However, NCDEM regulations did allow higher loading rates on a case by

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1./ These systems are now regulated by the N.C. Division of Health Services through the County Health Department, Environmental Health Section.

case basis where it could be demonstrated by the applicant that there would be no harm to the environment. A case in point is the fact that NCDEM did grant a permit for increased loading rates at 3 gpd/sf. for a ground absorption effluent disposal system serving the Beacon's Reach Condominium complex at Pine Knoll Shores on East Bogue Banks. In this case, the site consisted of soils of the Newhan-Corolla complex. The Newhan soils in particular are excessively well-drained with very rapid percolation rates. The hydraulic conductivity of deep sandy soils similar to the Newhan series range from 20 to over 100 inches/hour thereby allowing greater loading rates.

Now, under State Health Department regulations, the maximum loading rate is 1.2 gpd/sf with a 3 foot trench bottom and minimum line spacing of five (5) feet on center. This equates to a maximum potential loading of 31,450 gallons per acre assuming sandy soils (see Table 4.3). However, higher loading rates are still possible on a case-by-case basis.1./

4.2.4 Land Application by Rotary Distributors

This method of effluent disposal is relatively new and is particularly applicable to the coastal area of N.C. where sandy soils with high percolation rates are prevalent. This system uses rotary distributors similar to those employed on conventional trickling filters to disperse effluent into a prepared circular bermed pit of sandy soil. Figure 4.3 shows a typical

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1./ Personal communication with Mr. Steve Steinbeck, Environmental Health Section, Division of Health Services, Raleigh, N.C. (September 3, 1982).

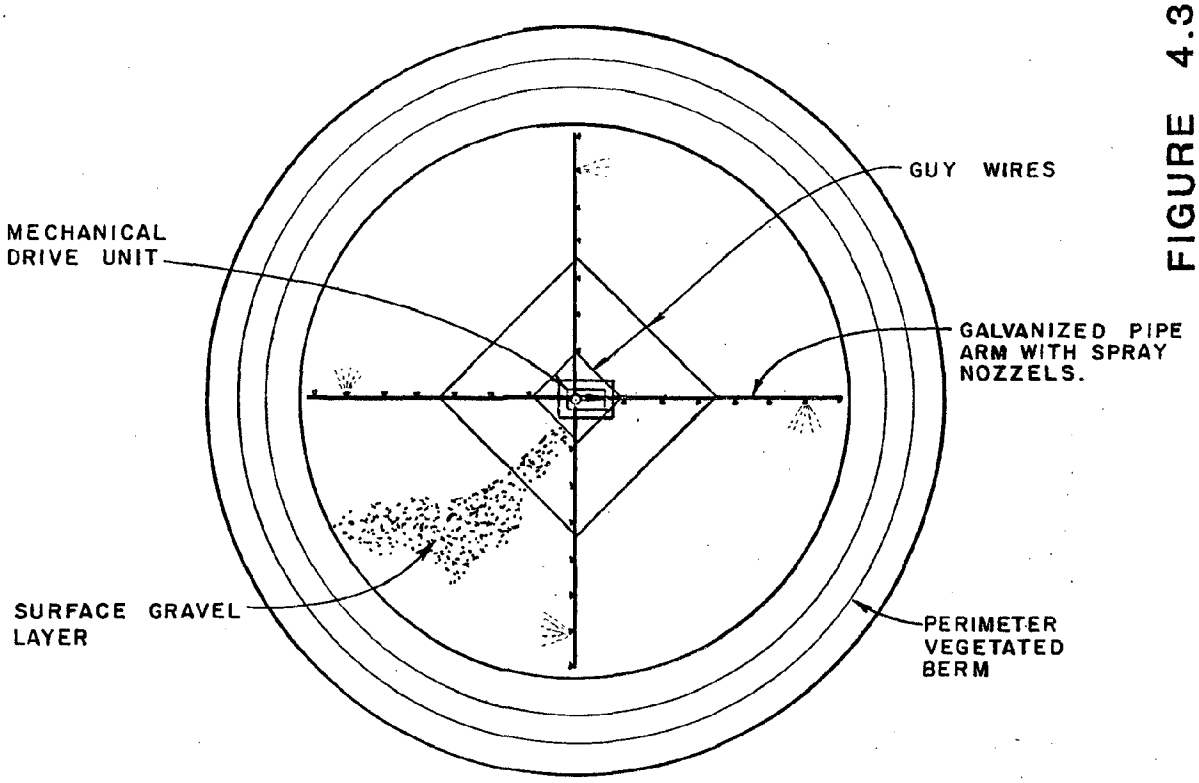
TABLE 4.3

MAXIMUM EFFLUENT LOADING RATES BASED ON SOIL TEXTURE[1./]

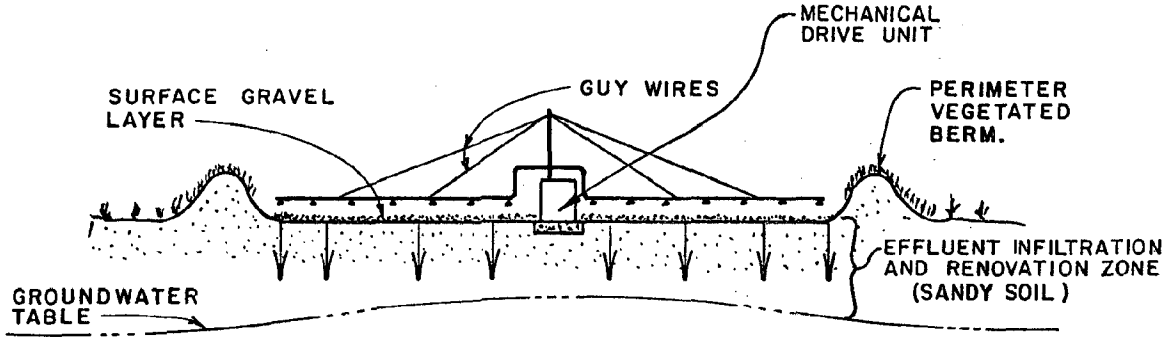
SOIL GROUP	SOIL TEXTURE CLASSES		APPLICATION RATE (gpd/ft^2)	RANGE OF MAXIMUM LOADING PER ACRE (gals)
I	Sands	Sand Loamy Sand	1.2 - 0.8	31,450 - 20,967
II	Coarse Loams	Sandy Loam Loam	0.8 - 0.6	20,967 - 15,725
III	Fine Loams (With PS structure)	Sandy Clay Loam Silt Loam Clay Loam Silty Clay Loam	0-6 - 0.4	15,725 - 10,483
IV a	Clays (Kaolinite or 1:1 with PS structure)	Sandy Clay Silty Clay Clay	0.4 - 0.2	10,483 - 5,242
IV b	Clays (Montmorillonite or Mixed Mineralogy)	Sandy Clay Silty Clay Clay	Unsuitable	----------

1./ Source: N.C. Department of Human Resources, Division of Health Services, Environmental Health Section. July 1, 1982. Laws and Rules for Ground Absorption Sewage Treatment and Disposal Systems.

FIGURE 4.3



PLAN VIEW
N.T.S.



ELEVATION
N.T.S.

DIAGRAM OF A ROTARY DISTRIBUTOR SYSTEM

FIGURE 4.3

rotary distributor installation. Loading rates of up to 8 to 10 gallons per square foot are possible with this system. However, this overall application rate may be reduced when spacing between rotary distributors are taken into consideration. Key factors in the design of such systems involve soil characteristics, hydraulic conductivity of the soils and the influence of the groundwater table. Distance between distributor units is also critical to prevent a "mounding" of the groundwater table and a potential break-thru of effluent to the surface. Each system must be designed on a case-by-case basis following an evaluation of soils and hydraulic characteristics of the site. The system is attractive to developers due to the fact that the loading rates which are allowed normally require the dedication of less land to wastewater disposal than the other methods heretofore mentioned. Also, the equipment is basically simple to operate and maintain. There are several successful operations on Bogue Banks at the present time.

4.3 Effects of Land Application of Effluent on the Surficial Sands Aquifer

Regardless of the method used to dispose of effluent whether it be by gravity or pressure feed drain fields (septic tanks or ground absorption package plant systems), by spray irrigation, or by rotary distributors, the receptor of the effluent is the groundwater aquifer on Bogue Banks. The effluent receives some degree of treatment in the soil prior to its entrance into the groundwater table. Effluent from septic tanks carries a greater burden of pollutants and so has the greatest potential to degrade

the quality of the groundwater than effluent from the other sources. Thus, a continual proliferation of septic tanks will ultimately result in a measureable and significant degradation of the groundwater aquifer. It is most difficult to predict when this will occur and how many septic tanks per unit of land area are needed before this danger point is reached. However, if septic tanks are sited on unsuitable soils, the break thru of pollutants to the groundwater and transmission to surface waters can occur at densities of only one septic tank drain field per four acres. (See Section 4.1.3). Therefore, it can be concluded that the continued use of septic tanks will ultimately result in the degradation of the groundwater aquifer and possibly migration of pollution to the adjacent sound waters (Bogue Sound). Once underground water tables do become contaminated, they are often technologically impossible or prohibitively expensive to clean up.

4.4 Municipal, Central or Regional Sewer System

4.4.1 General

There are several advantages of a central sewer system for a rapidly developing area such as Emerald Isle. Beyond the obvious advantages associated with the prevention of pollution and protection of the environment, it provides more responsible control over wastewater treatment and disposal due to a generally higher quality of plant operation and more sophisticated monitoring requirements by State regulations. It also allows for the better use of available land for overall development, and would allow the development of smaller lots at Emerald Isle which are not now

developable with septic tanks. It therefore, encourages "fill-in growth" rather than "urban sprawl" provided, of course, that the sewer system is properly phased.

4.4.2 Status of 201 Plan

Preliminary planning for the development of a central sewer system for Emerald Isle has already been conducted under the EPA Construction Grants Program and is included in the very detailed report entitled, "Swansboro Area 201 Facility Plan", November, 1977 (Revised). The 201 facilities planning area includes the Town of Swansboro in eastern Onslow County and the western segment of Carteret County including the communities of Cape Carteret, Emerald Isle, Indian Beach and Salterpath.

Under the 201 Facilities Planning program, several regional and subregional plans were formulated and evaluated. The selected facility plan for the Carteret County segment of the planning area falls within the framework of the selected regional "Plan C-1." This plan calls for the future construction of two separate facilities, one to serve the Town of Cape Carteret on the mainland and one to serve West Bogue Banks including Emerald Isle, Indian Beach and Salterpath. However the plan also calls for the continued use of individual privately owned septic tanks and small aerobic treatment systems until such time that a publicly owned central sewer system becomes economically feasible to construct. It was recommended that the plan be re-examined by local governmental officials and citizens on a regular basis to determine when it would be economically feasible to implement. The rationale of approach for this was that when it becomes economically feasible to build wastewater treatment facilities

for West Carteret County, the local governments would have a mechanism in the form of Plan C-1 to pursue the project.

The plan as written calls for the treatment facility to be constructed on a 10 acre site at Emerald Isle in the vicinity of the Cameron Langston Bridge. (However, the plant could be constructed in any area strategically located to the area it is to serve). Under the plan, the recommended treatment facility would have an initial design capacity of 1.3 MGD and would employ the oxidation ditch modification of the extended aeration-activated sludge process. Treated and disinfected effluent would be pumped to the beach margin via a force main for discharge to the Atlantic Ocean by an outfall and diffuser system of suitable length. The plan calls for the accomplishment of a marine site survey for the ocean outfall prior to final design of the pipeline. Sludge generated during the treatment process would be aerobically digested and dewatered on sandbeds. Ultimate disposal of dried sludge would be in the Carteret County Sanitary Landfill located near Newport.

Associated with the plan for West Bogue Banks will be the construction of an interceptor sewer system and ancillary collector sewers to serve the individual communities participating in the plan. These systems will be constructed with the treatment works. Table 4.4 summaries the costs (in 1977 dollars) associated with the systems as they were proposed in the 201 plan.

The current status of the 201 Plan is that it has received both State (NCDEM) and EPA approval. However, the availability of federal funds for the implementation of the plan is uncertain due to recent reduction in appropriations for the Construction

TABLE 4.4

COST DATA
CENTRAL SEWER SYSTEM FOR EMERALD ISLE[1./]

Item/Description	Capital Cost
1. Secondary wastewater treatment facility, 1.56 MGD, with ocean outfall.	$2,938,000
2. Phase I wastewater collection system for Town of Emerald Isle[2./]	2,860,953
3. Interceptor system.	2,319,972
TOTAL COST (1977 DOLLARS)[3./]	$8,118,925

Notes:

1./ Based on Swansboro Area 201 Facility Plan (1977).

2./ Based on gravity sewer system.

3./ Caution should be exercised in the use of these cost figures as they are based on 1977 dollars and a specific system layout that is subject to change to accomodate present conditions.

Grants Program and the incomplete status of an EPA sponsored Generic Environmental Impact Statement (EIS) on the North Carolina Barrier Islands.1./ Also, the West Bogue Banks area project has a low level of priority on the State's Construction Grants funding list at the present time, primarily influenced by EPA's EIS action mentioned above. This list sets forth over 400 eligible projects in the State of North Carolina for which federal grant funds could be committed. However, recent cutbacks in funds will allow only the first 20 or 30 high priority projects on the list to be funded each year. Therefore, in view of these recent developments, it appears unlikely that federal monies will be available to fund a central sewer system for Emerald Isle in the near future under the current policies and programs of the USEPA.

Despite the unfavorable federal funding picture at this time, the 201 Plan still provides a good basic framework for the development of a central sewer system for Emerald Isle. Its thorough analysis of regional system alternatives still retains its validity. The selected site area for the treatment facility is still appropriate as is the treatment plant process scheme (oxidation ditch). The proposed method of effluent disposal by means of an ocean outfall is still valid. On the other hand, other aspects such as service areas and costs need updating to conform to existing conditions and ultimate effluent disposal methods should be reevaluated.

1./ Claude Terry and Assoc., Inc., December, 1981. North Carolina Barrier Islands Environmental Impact Statement (Draft). Report prepared for USEPA, Region IV, Altanta, GA.

4.4.2 Effluent Disposal Alternatives

4.4.2.1 General

One of the primary concerns associated with the development of a central sewer system for Emerald Isle will be the ultimate disposal of treated effluent. Several alternatives are possible. These are discussed in the following sections.

4.4.2.2 Ocean Disposal

In the 201 Plan, ocean disposal of treated effluent was selected as the best plan for the area. Recent developments including the completion of a recent general study of ocean outfalls by the State[1./], and the completion of a specific site survey for an ocean outfall for Dare County, NC[2./] have demonstrated the basic soundness of this approach. However, the costs associated with ocean disposal of treated effluent have proved to be high. Thus, in this instance, it would be difficult to implement a plan with an ocean outfall system without federal participation in the project. Also, the State of N.C. still needs to modify its regulations to permit a discharge of treated effluent. This administrative action is still pending as of this writing (State regulations permitting ocean outfalls are expected to be promulgated in March, 1983).

1./ N.C. State University, East Carolina University and University of North Carolina at Chapel Hill, 1979. Ocean Outfall Wastewater Disposal, Feasibility and Planning, Raleigh, N.C.

2./ Brown & Caldwell, February, 1982. Marine Survey for Ocean Outfall, Dare County, N.C. Report prepared for Dare County Board of Commissioners, Manteo, N.C.

4.4.2.3 Subsurface Disposal

This method, previously discussed under Section 4.2.3 above, can be used to dispose of effluent from a central sewer system. However, under current regulations, this method requires large land areas with suitable soils. For example, for a nominal 0.5 MGD first phase treatment facility for Emerald Isle, a total of about 16 to 24 acres of land would be needed for effluent disposal. Land at Emerald Isle is at a premium and so this system would not really be feasible unless the treatment facility and effluent disposal system were to be located on the mainland. Several large tracts of land are available on the mainland. One such tract was identified in the 201 Plan as being suitable for land application. That site is located north of Cape Carteret and east of the Star Hill Golf Course.

4.4.2.4 Spray Irrigation

This method of effluent disposal was investigated in considerable detail in the 201 Plan and was found to be infeasible in this instance for several reasons among which were, large land requirements, high costs and public opposition to this mode of disposal. Again, the only available site available for this method of disposal is located near the Star Hill Golf Course at Cape Carteret on the mainland.

4.4.2.5 Rotary Distributors

Of the range of options available for land disposal, this method appears to have the greatest potential (see Section 4.2.4

above). Permissable loading rates are such that land requirements are minimized. For example, for an initial flow of 0.5 MGD, a total land area of only about 8 acres would be required to dispose of treated effluent assuming a loading rate of 10 gpd/sf, an array of twelve 60 foot diameter rotary distributors and a center to center spacing of about 180 feet. For the first phase system, there appears to be enough land at Emerald Isle to accommodate a rotary distributor effluent disposal system. Alternately, there may be several suitable sites on the mainland.1./

4.4.3 Collection System Alternatives

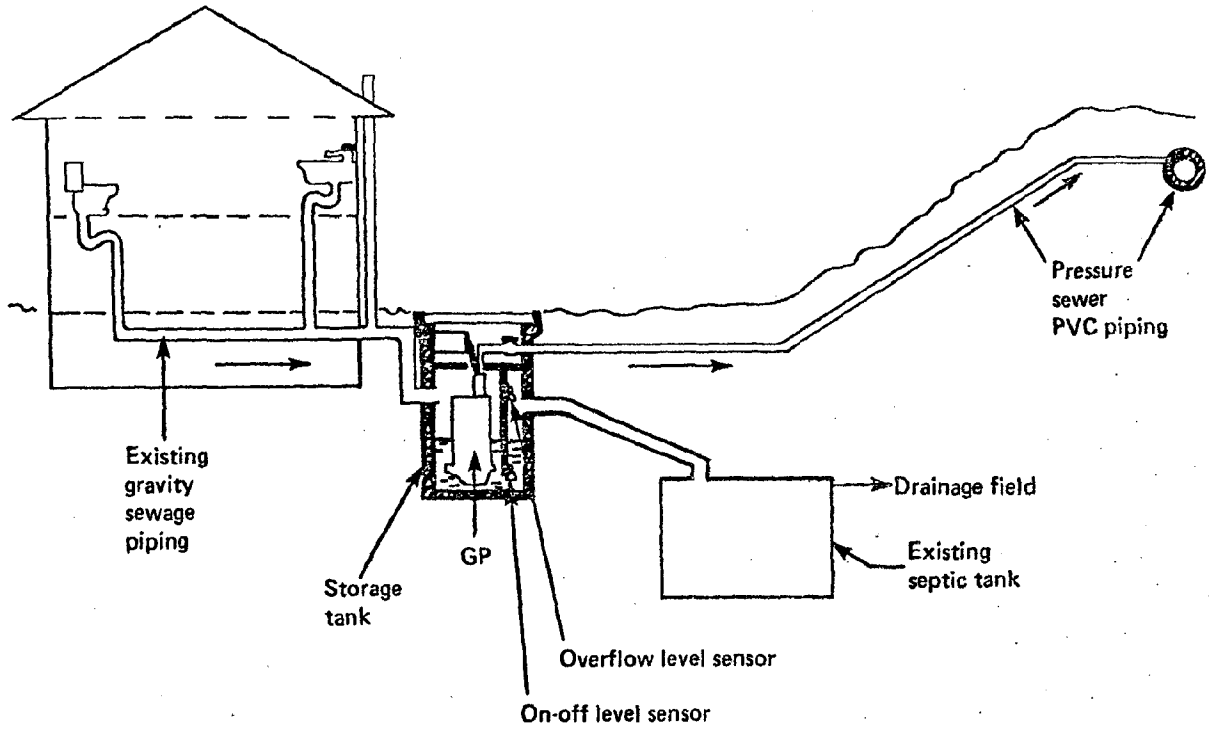
There are three basic types of collection systems: conventional gravity, vacuum and pressure systems. Vacuum sewers have proved to be more costly for beach areas than conventional gravity or pressure systems and so no further consideration is given to this system here. A conventional gravity collection system consists of gravity sewer mains, manholes, laterals, services, cleanouts, lift stations, forcemains and other standard appurtenances which are necessary to collect wastewater from homes. The system would direct all of the collected wastewater from the Town to a central lift station. This station would pump the collected wastewater via a forcemain to the treatment facility site. Each segment of the system would be tied into the main lift station by a series of gravity collection subsystems draining to smaller lift stations which would pump into a common forcemain which would run linearly along the main highway.

1./ Note: Site suitability must be determined based on soils and hydrogeologic analyses (see Section 4.2.4 above).

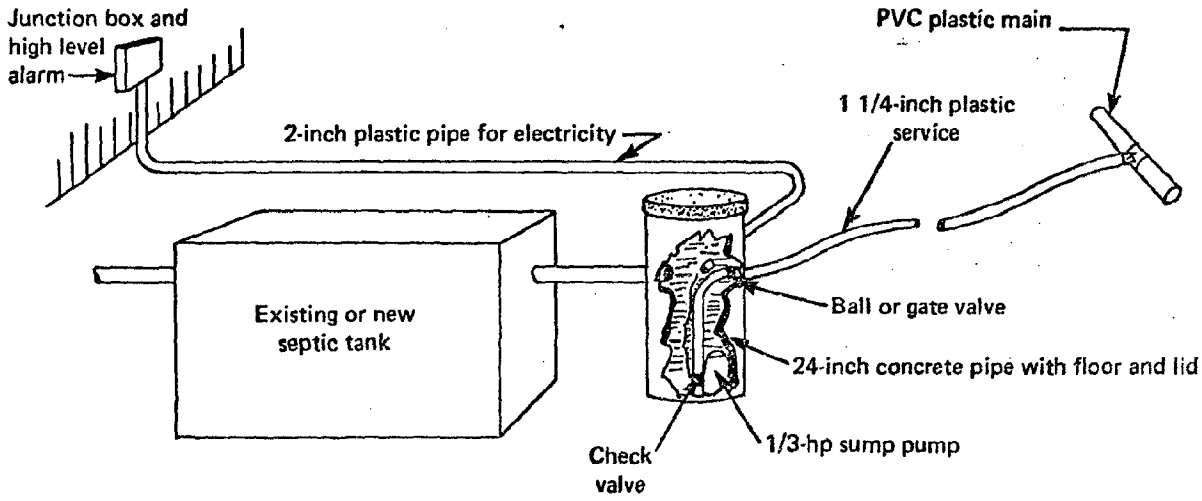
A pressure sewer system is basically the reverse of a water distribution system. The latter employs a single inlet pressurization point and a number of user outlets, while the pressure sewer system embodies a number of pressurizing inlet points and a single outlet (a forcemain). The user input to the pressure main follows a generally direct route to a gravity sewer. The gravity sewers collect the wastewater to a lift station and all lift stations ultimately discharge to the main lift station and thence to the treatment works.

There are two major types of pressure sewer systems namely, the grinder pump (GP) system and the septic tank effluent pump (STEP) system. These are depicted in Figure 4.4. The major differences between these two alternative systems are in the on-site equipment and layout. However, with the STEP system the septic tanks must be pumped periodically and the sludges disposed of by some acceptable method. In view of the fact that septage disposal would pose a problem at Emerald Isle. The grinder pump (GP) system would be more appropriate. However, due to the high costs associated with grinder pumps and some unsatisfactory records of performance in similar installations, submersible sewage (solids handling) pumps are often specified in lieu of grinder pumps.

A typical pressure sewer system for beach areas consists of a series of gravity sewer subsystems which run in a linear fashion along the beach. All dwellings which are located adjacent to the small diameter pressure mains are served by individual pumpout units (IPU's). Those dwellings which are



Typical grinder pump installation.



Typical STEP system.

FIGURE 4.4

PRESSURE SEWER SYSTEM ALTERNATIVES

located adjacent to the gravity sewer segments will be served by conventional house lateral connections. Therefore, under this concept, there are two classes of users - the "IPU user" and the "gravity sewer user". One's classification will depend on one's location on the system.

The design criteria used for the design of pressure sewers are summarized in Table 4.5. The system concept normally calls for each householder to purchase the IPU which services his dwelling (business, etc.). This purchase is normally covered under the connection fee. The individual homeowner is then responsible for the operation and maintenance of his unit. He also pays the small electrical power costs associated with the unit as a part of his normal monthly electric bill.

Experience from the design of collector sewer systems for other similar coastal areas of North Carolina has shown that pressure sewer systems are less costly and, therefore, are preferable.

4.4.4 Phased Development of System

Phased development of a central sewer system makes sense for several reasons including minimization of capital costs and to prevent the stimulation of development in sparsely developed areas. Such a system can be tailored to serve only those specific areas which need service at this time to correct existing problems. With careful planning, the systems can be designed to accommodate future additions and expansions on an incremental basis.

TABLE 4.5

STATE DESIGN CRITERIA
FOR PRESSURE SEWER SYSTEMS[1./]

Individual Pumpout Units (IPU's)

1. Simplex submersible sewage pumps owned by householder
2. Electrical power from individual house
3. Alarm inside of house
4. No standby power required
5. Sump storage based on history of power outages[2./]
6. Standby pumps required (2 per 100 pumps installed)
7. Assume 7-year life per pump[3./]
8. Cleanouts at ends of lines and at all bends.

1./ Based on discussions with Engineering Section, NCDEM, DNRCD, Raleigh, NC (March, 1979).

2./ Assumes that systems will be shut down during hurricane conditions.

3./ Replacement cost = $300/pump.

4.4.5 Central Sewer System Plan for Emerald Isle

Based on the rationale presented above, a central sewer system for Emerald Isle should be developed on a phased basis and should consist of the following basic elements:

(1) Combination gravity/pressure sewer collector system.

(2) Common forcemain interceptor to central wastewater treatment system.

(3) Oxidation ditch treatment facility followed by a tertiary filter.

(4) Rotary distributor type effluent disposal system.

The development of a detailed cost estimate for this system is beyond the scope of this study. However, once it is decided to develop such a system, the Town should authorize the production of a Preliminary Engineering Report which would address these issues and examine the economics of such a system including individual user costs.

It takes several years to plan, design and construct a central sewer system. Following is a typical schedule which would be applicable to the Emerald Isle situation:

Major Action	Time for Completion (Months)
(1) Preliminary Engineering Report (PER)	3-6
(2) Regulatory Agency Approval of PER	2-3
(3) System Design (Plans & Specifications)	6-8
(4) Regulatory Approval of Plans and Specifications	2-3

	Major Action	Time for Completion (Months)
(5)	Arrangement for Project Financing	3-4
(6)	Advertisement for Bids	2
(7)	Award of Contracts	1-2
(8)	Construction of System	12-18
	Total Time Required	31-46 months
		(3-4 years)

SECTION 5: PROPOSED WASTEWATER TREATMENT/DENSITY RELATIONSHIPS

5.1 Development Density Guidelines

Based on the information presented in the previous sections of ths report, it is possible to suggest some guidance relative to wastewater disposal and density relationships. As indicated previously, within the "present state of the art" it is not possible to simplify the wastewater disposal problem enough to indicate with any degree of confidence the number of septic tanks and/or other subsurface wastewater disposal systems per given area of land that will cause irrepriable harm to the environment. Also it is not possible to draw exact parallels between studies done in other areas with varying soils, water table and development conditions with the Emerald Isle situation. However, it is possible to set forth some conservative guidelines which, in the absence of absolutes, can be used as development guidelines until the more reliable technical data alluded to above which can be used with complete confidence is available.

Table 5.1 presents a set of guidelines relative to wastewater treatment modes, development modes, site conditions (soils) and maximum densities. The rationale for each density criterion set is indicated in the table with further detail below. The density guidelines are necessarily conservative due to the general lack of complete understanding of all the factors included. However, the density guidelines do reflect the state of the art as of this writing.

The density recommendations presented in Table 5.1 should be considered as "guidelines" and not hard and fast rules. For

TABLE 5.1

SUGGESTED GUIDELINES

WASTEWATER TREATMENT/DENSITY RELATIONSHIPS

	Soils/Development Mode/ Wastewater Treatment System	Max. Density (Units/Acre)	Minimum Lot Size (Sq.Ft.)	Source/Reference/Comment
1.	Suitable Soils: Single family dwelling Standard septic tank system	3	14,520 (Use 15,000)	Based on NCDEM "Coastal Regulation" 2-79 as amended, Section IV-6.
2.	Provisionally Suitable Soils: Single family dwelling Standard septic tank system	2	20,000	Generally accepted criteria operable in N.C. coastal area. Subject to modification based on specific soil types on specific site.
3.	Unsuitable Soils: Single family dwelling Modified septic tank system a. Low pressure pipe (LLP) system b. Mound system	 1 1.3	 43,560 32,670	Based on need to provide large portion of site to modified septic tank systems. (See Section 4.1).
4.	Suitable Soils: Multifamily units Septic tanks	3	N/A	Based on NCDEM "Coastal Regulation" 2-79 as amended, Section IV-6.
5.	Provisionally Suitable to Unsuitable Soils: Multifamily units Package WWTF	10	N/A	Based on current zoning regulations and to Land Use Plan guidelines set by Town Board.
6.	Any Soil Type: Single family dwelling Central sewers or community sewer available	6.2	7,000	Based on minimum lot size of 7,000 sq.ft. to allow these lots to be developed where central sewers are provided.
7.	Any Soil Type: Multifamily units Central sewers available	10 to 15	N/A	Proposed density range limit to allow some flexibility for controlled development where central sewers are provided. Higher density should be offset by higher greenspace requirements.

example, in the case of modified septic tank systems on unsuitable soils, it may be possible to construct a low pressure pipe system or a mound system on a specific lot which is smaller than the minimum lot size indicated and still meet all the required setbacks, etc. Therefore, some latitude for flexibility must be made in applying these guidelines in such cases.

The maximum density of 10 units per acre for multifamily units which meet a current local zoning law and State requirements is somewhat arbitrary in that it is based more on aesthetics and local desires than on specific engineering and planning principles relative to wastewater treatment and disposal. Nevertheless it represents a good conservative compromise between the desire to develop versus the other extreme to restrain development. Current wastewater treatment and disposal technology is generally capable of handling the wastewater from these development densities provided that current State regulations are adhered to during design and construction of the systems.

The data in Table 5.1 indicates that with the provision of a future central sewer system, higher densities than permissable under current regulations would be possible. Again the maximum densities set forth in the table are based primarily on local factors. Single family development will then be possible on the smaller lots at Emerald Isle, even some that might not be developable under existing constraints. Considering all other development factors a minimum lot size of 7,000 square feet can be developed with a central sewer system. In the case of

multiunit development, a density range of 10 to 15 units per acre was selected following consultation with the Town. It should be emphasized that higher densities than this range can be accommodated by a central sewer system. However, the density range indicated is more in keeping with the local desire to develop as a "family beach" in harmony with the approved Land Use Plan.

It also should be emphasized that even if these guidelines are strictly followed that the ultimate buildout of the Town of Emerald Isle at some unknown future date will result in the generation of a peak seasonal wastewater flow of about 5 MGD (see Section 2.2 above). A central sewer system will be required to accomodate this flow so as to minimize any possibility of harm to the environment due primarily to wastewater disposal practices.

With these facts in mind, it is possible to reduce the impact of these inpending developments by giving consideration to reducing maximum permissible densities by changes to the zoning law. One method to accomplish this would be to simply decrease the maximum density from 10 units per acre down to 8 units per acre. Another technique would be to rezone all or some portion of the 1,400 acres of land now under the RMF, INT and RMH zoning categories which allow multiunit housing projects to R-1 or R-2 which allow single family homes or duplexes (see P.2-3 above). Or finally, a more elaborate reevaluation of the Town's present land use plan and zoning regulations might be undertaken using a type of "Land Use Intensity System" analysis which would establish an entire new set of criteria for development densities under any combination of conditions or circumstances. In any case, before

actions of this type are undertaken, the Town should conduct public hearings to receive public input on the potential results of such actions. Once acceptable goals and objectives are established, the growth and development of the community can be controlled according to the established guidelines and standards.

5.2 Proposed Modifications to Present Land Use Plan or Zoning Ordinance to Accommodate Proposed Density/Sewer System Relationships

In harmony with the suggested density guidelines set forth in Table 5.1, consideration should be given to the following changes to the existing zoning ordinance and/or Land Use Plan:

(1) An immediate amendment to the "Subdivision Regulations Checklist" to include review of plans and specifications for privately owned and operated wastewater treatment facilities by the Town Engineer to insure compatibility with a future municipal or regional sewer system. (See Section 6 following).

(2) An amendment to the Land Use Plan to include this report as an integral part thereof.

(3) At the time when a central sewer system is under construction,

   (a) An amendment to the Zoning Ordinance to permit development of 7,000 sq. ft. lots where central sewers are available.

(b) An amendment to the Zoning Ordinance to permit multi-unit densities in the range of 10 - 15 units per acre where central sewers are available. This increase in density should be offset by requirements of additional greenspace for the total development.

SECTION 6: PROPOSED CONSTRUCTION STANDARDS FOR PRIVATE PACKAGE SEWER SYSTEMS SO AS TO INSURE COMPATIBILITY WITH A FUTURE CENTRAL SEWER SYSTEM

6.1 Proposed Standards

Plans and specifications for wastewater collection, treatment and disposal systems serving private developments are normally reviewed by NCDEM or the Carteret County Health Department prior to the issuance of a permit to construct. NCDEM reviews those systems using spray irrigation or rotary distributors for effluent disposal. The local Health Department with the assistance of the State Division of Health Services reviews plans for systems using ground adsorption for effluent disposal. This review is usually sufficient to insure that the system design will meet minimum State standards. However, these reviews give no consideration to the necessity for eventually interconnecting these independent systems to a future municipal or regional system. Also, once the plans and specifications are approved, the construction normally proceeds without any inspections by NCDEM or the Health Department to insure conformity with the plans and specifications. Therefore, to insure compatibility with a future municipal or regional wastewater system, the Town of Emerald Isle should institute the following procedures for all applicable projects:

(1) Require the developer to submit a set of detailed plans and specifications of the proposed sewer system following approval of such by NCDEM or the Health Department. The Town, acting through a duly qualified professional engineer, should review the plans and specifications with respect to the following items:

(a) Gravity sewer lines entering a lift station or package wastewater treatment facility should enter a manhole so designed to permit future connection to a central sewer system.

(b) The site for the package sewage treatment plant should be large enough to accommodate a future interconnection to a central sewer system by a gravity sewer line or by means of a future lift station (if required). The provisions for such a future connection should be shown on the plans. Any easements on the developer's property required for the future connections should be identified and shown on the plans. Also, prior to final approval by the Town, such easements should be codified in the appropriate legal documents.1./

1./ Note: The legality of this proposed requirement was pursued with Mr. Milton Heath of the Institute of Government, Chapel Hill, N. C. At issue is weather a community can legally require a developer to install one type of sewer system, i.e., a package wastewater treatment plant, and also require the developer to make provision for a future system of another type, i.e., a central sewer system. Mr. Heath indicated that this question has not been legally tested in North Carolina. However, Mr. Heath indicated that there have been similar precidents set in other areas. For example, a suburb of Philadelphia, Pennsylvania allowed a developer to install septic tanks in a subdivision on the condition that he also install (simultaneously) "dry" sewer lines for future use once a central sewer system was available to serve his subdivision. Therefore, based on this case, it would not be legally improper for a community to require a developer to dedicate easements for future use for an interconnection to a central sewer system. However, it would be important for the easement to be legally recorded at the time of the other approvals associated with the proposed development.

In addition, many existing permits for package treatment plants issued by NCDEM contain the proviso that such systems must be abandoned once central sewers become available.

(c) The treatment facility site and area for the future lift station should not be subject to flooding and should be cleared and grubbed by the developer's contractor. The area of the site reserved for a future interconnection should not be used to dispose of or to bury construction debris which could interfere with the installation of the future interconnective facilities.

(d) Where ditches are crossed by sewer lines, the pipe material should be ductile iron. No other pipe materials will be acceptable for this purpose.

(e) Gravity sewer lines should be no less than 8 inches in diameter.

(f) Manholes should be no further than 350 feet apart.

(2) During the construction of the project, the Town should inspect the installation for compatibility with the previously submitted plans and specifications. The cost for these inspections should be covered by the Building Permit fee. If necessary, building permit fees for multiunit housing projects should be increased to accommodate the increased inspections required. During construction, the following items should be given particular attention.

(a) As most developers will be using PVC or transite pipe, proper bedding and compaction of the pipe are most important to prevent deflections and future infiltration problems.

(b) Pipe entrances into manholes should be inspected to insure a tight connection and no infiltration.

(c) No sewer taps should be made to vacant lots to prevent inflow problems.

It should be clearly pointed out that the purpose of the aforementioned reviews and inspections by the Town (or by delegation, its Consulting Engineer) is not to recheck another engineer's design work. Rather, it is to insure that the proposed project is in harmony with and compatible with the long term interests of the Town of Emerald Isle to afford efficient, economical interconnections to a municipal sewer system when it comes on line.

SECTION 7: CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

Based on the foregoing information and analysis, it may be concluded that:

- Pressures for the development of Emerald Isle will continue, and possibly accelerate in the future. A high percentage of this development in the near future is expected to be medium to high density in the form of condominium and/or multifamily type units.
- Present wastewater (sewage) disposal practices are confined to septic tanks (in the case of individual lot developments) and to small, individual "package" wastewater treatment plants (for multiunit housing projects and campgrounds).
- A general analysis of existing soils on Emerald Isle indicate many areas contain soils that are adaptable to septic tank use; however, in other areas soils are not conducive to this practice. Often these soils are interconnected by the system of dune ridges and swales that complicate the "acceptable area" use problem. (See Map 4.2). Most of these longitudinal bands of unsuitable soils are located in the western sector of the Town and within the large tracts zoned for multifamily use.
- Septic tanks will probably continue to be used in some areas for years to come. Package treatment plants employing ground discharge of effluent will proliferate unless a central wastewater treatment plant is constructed.

The combination of ground discharge of sewage wastes from these two sources would indicate that some contamination of the groundwater aquifer at Emerald Isle is already occuring (see Section 4.1.3). Also, close proximity of these systems to estuarine waters represent a real pollution threat to those fragile areas.

- Based on existing zoning regulations and development trends, a total buildout of all available lots at Emerald Isle could result in a peak seasonal population of 68,250 persons. Assuming a wastewater loading of 70 gallons per capita per day, a peak seasonal sewage flow could amount to almost 5 MGD (4.78 MGD). Without the benefit of a central sewer system, this flow will represent a significant impact on the environment.
- A rezoning of some 1,400 acres of vacant land at Emerald Isle now zoned for multifamily use to single family or duplex uses could effectively reduce the total peak seasonal population that can be accomodated. It would also reduce the total sewage loading to about 3 MGD (2.79 MGD) at total buildout. However, this potential action will not foreclose the need for a central sewer system. In fact, it may accellerate such a need due to the further proliferation of septic tanks for wastewater disposal.
- A survey of existing and proposed package wastewater treatment facilities serving multiunit housing projects at Emerald Isle revealed that there are presently six (6) such facilities ranging in capacity from 26,500 GPD to 75,000

gpd. These facilities have a combined total capacity of about 300,000 gpd.

- Recent studies conducted by investigators from N. C. State University Department of Soil Science indicate that the location of the groundwater table is the most important factor affecting the movement and treatment of septic tank effluents. Contamination of the groundwater around the septic tank was generally confined to within 25 feet of the systems, but more widespread movement was noted in several continuously saturated cases. Therefore, the greater the density of septic tanks per given area of saturated soils, the greater the possibility of pollution of the groundwater aquifer from multiple septic tank systems.
- Studies conducted by the N. C. Division of Environmental Management revealed that coastal watersheds with estimated densities greater than one septic tank drainfield per four acres were contaminated by bacteria and closed to shellfishing. Contamination of estuarine waters can be expected when dense development using septic tanks occurs on unsuitable soils adjacent to such waters.
- The so called "alternative" septic tank disposal systems namely, low pressure distribution systems and mound systems (see Section 4.1.4), do not appear to lend themselves for general use at Emerald Isle because of increased land (space) requirements and the relatively small building lot sizes existing in the community. In general, minimum lot

sizes for low pressure distribution and mound system are one acre and 0.75 acre, respectively.

- Package wastewater treatment facilities can achieve high levels of removal of pollutants, if they are properly operated and maintained. However, their documented record of performance in the past has been traditionally less than satisfactory due to a lack of adequate operation and maintenance.
- In order to prevent undue harm to the environment from continued growth and development, the Town of Emerald Isle will ultimately need a central sewer system. Preliminary planning for such a system should begin now.
- The provision of a central sewer system will permit development densities greater than those permitted under existing zoning regulations should this be desired. However, strong zoning regulations and proper phasing of the wastewater collection, treatment and disposal (sewer) system should control any growth stimulating effects of the system, while at the same time protecting the environment that makes Emerald Isle such a desirable place to live.

7.2 Recommendations

Based on the foregoing discussions and conclusions, the following recommendations are offered for consideration:

- In view of the fact that septic tanks will probably continue to be used for wastewater disposal in some areas for the foreseeable future and some contamination of the

groundwater (surficial sand) aquifer at Emerald Isle is in all likelihood occuring (see Section 4.1.3), it is recommended that the Town of Emerald Isle seriously consider, for all new construction, passing an ordinance requiring mandatory connections to the existing central water system operated by the Bogue Banks Water Corporation, Inc. as a public health measure. For existing development, the ordinance should encourage interconnection to the central water system provided such is available to the homeowner.

- Septic tank installation should not be allowed to exceed the criteria suggested in Table 5.1 (follows page 5-1). Also, such systems should not be used in the interdunal troughs (see Map 4.2 and Section 4.1.1).
- In view of the present growth rate and patterns, serious consideration should be given to the early development of a municipal sewer system to serve the Town of Emerald Isle. Preliminary planning for such a system should begin immediately.
- To assist in accomplishing this, consideration should be given to encouraging future developers to construct their wastewater treatment facilities at a central location (on land owned by the Town), dedicating those facilities to the Town (or the locally established Water and Sewer Authority) for operation and maintenance.
- Due to the fact that such a central sewer system is an ultimate necessity for the Town of Emerald Isle, the Town should institute efforts to acquire a suitable wastewater

treatment facility site. As indicated in the 201 Plan and the CAMA Land Use Plan, the apparent best location for such a site under the present circumstances is in the vicinity of the Cameron Langston Bridge. This area is projected to have the greatest growth potential and it is highly likely that the community's first phase sewer system will be constructed in this general area.

- To insure compatibility with a future municipal or regional wastewater system, it is recommended that the Town institute procedures to review the plans and specifications and construction of privately owned package wastewater treatment facilities serving multifamily housing developments as outlined in Section 6.
- Although the ultimate construction and operation of a central sewer system at Emerald Isle would permit development densities in excess of that now permitted under existing zoning regulations, we feel that even the presently authorized density criteria should be reevaluated. To protect the environment and in order to preserve the general character of the Community as a "good, clean family beach" as indicated in the Land Use Plan, consideration should be given to decreasing the maximum density from 10 units/acre to 8 units/acre of developable land zoned for multifamily use. This factor becomes even more important when total potential population and wastewater loading projections are taken into consideration (as discussed in Section 2). The rational basis for this recommendation

lies in the nature of the soils at Emerald Isle. The interdunal troughs of unsuitable soils identified on Map 4.2 and described in Section 4.1.1 and Appendix B represent severe impediments to the use of any form of wastewater disposal using ground absorption techniques. A reduction in density will tend to reduce the impacts on the environment until a central sewer system becomes an operational reality.

- Once the central sewer system becomes a reality at Emerald Isle, consideration can be directed towards permitting higher densities (up to 15 units per acre) especially where developers are willing to offset such localized concentrations by dedicating additional greenspace for the total development so that the desired basic land use intensity criteria is not exceeded.

Respectfully submitted,

HENRY VON OESEN AND ASSOCIATES, INC.

William E. Burnett
Environmental Planner

Paul S. Denison, P.E.
Vice President

APPENDIX A

PRESS COVERAGE OF MORITORIUM

Emerald Isle special session

Town board meets to discuss condo moratorium

By BRAD RICH
News-Times Staff Writer

WHEN Richard Smith took office as Mayor of Emerald Isle, he pledged not to call special meetings of the town board unless matters of life and death were to be discussed.

At yesterday's special meeting of the town board, held at 2 p.m. in the town hall, Mayor Smith said rapid development of multi-family housing developments has become a matter of the town's life and death.

MAYOR SMITH, in a long monologue that opened yesterday's meeting, ticked off a list of what he considered serious problems and studies he felt needed to be undertaken to solve those problems.

All six of his major points led to one conclusion — the mayor felt the town needed to impose a moratorium on construction of group housing developments, a measure already taken by Pine Knoll Shores and Atlantic Beach.

THE MAYOR recommended the following measures be undertaken:

—A study of soil saturation and pollution levels from the town's septic tanks.

—A study of fire hazards and fire protection.

—A study of water availability.

—A study of the town's building codes.

—An effort to convince Carteret County to lower the density levels it allows in group housing projects so that pollution of the east end of Bogue Sound might be alleviated.

—A study of Emerald Isle's own population density.

PERHAPS the most serious of the problems, the Mayor said, was fire protection.

Mayor Smith said he had talked recently to several fire and rescue squad members, who told him that "Sooner or later, we're going to be called on to go in to a building and pull people out. We don't have any fire fighting equipment, but we will be called on to lay our lives on the line."

YESTERDAY, Fire Chief George Foster elaborated, describing a recent fire drill held at the new Point Emerald Villa condominium project.

He said water pressure was eight pounds per square inch. Point Emerald, according to Mr. Foster, is in a situation now where the town of Emerald Isle can do almost nothing to protect it from fire, except by using equipment from Cape Carteret. The same, he said, was true of the new Sound of the Sea project.

A RELATED problem is the drinking water situation. The Bogue Banks Water Co., Mayor Smith said, recently drilled a new well, "went down a considerable distance, and didn't find any water fit to use.

"Are we going to find ourselves in the situation of the old saying, 'Water, water, everywhere, Nor any drop to drink,' " the Mayor wondered.

TOWN commissioners, especially Richard Conover, who said he was glad the Mayor had "seen the light," supported the Mr. Smith's suggestions, but decided to wait until the June 8 regular meeting of the town board to take action on the moratorium question.

Between now and then, commissioners will be trying to come up with townspeople and other area residents who might be willing to serve on committees to study the problems.

Emerald Isle

Town commissioners impose moratorium on condos

By BRAD RICH
News-Times Staff Writer

EMERALD ISLE commissioners last night voted 3-2 to impose a 90-day moratorium on new multi-family housing projects, then amended that decision to allow consideration of projects already approved by the town planning board.

The amendment followed an ardent appeal by the developers of the planned 228-unit Pebble Beach Condominium project, whose request for approval of a preliminary plat came later on the agenda than the moratorium vote.

DEVELOPERS of the project argued that since their project had last month won approval by the planning board, the town board should at least consider the project.

"To us, 90 days is the same as nine months to a year," said attorney Frank Erwin, Jacksonville, who represented the developers. "We would have to wait until next March to begin marketing these units. It's difficult to market ocean front property during the winter."

BOBBY PITTMAN, Jacksonville, also representing the developers, argued that Pebble Beach surpassed most of the Emerald Isle condominium ordinance stipulations. He argued that developers have already spent in excess of $1.5 million getting the project to its current stage.

Mr. Pittman, against the advice of Mr. Erwin, informed the board of the developers' plans to donate $30,000 to the planned new Emerald Isle fire station after completion of the first two buildings in the project.

HE SAID Pebble Beach developers are not interested in making a quick dollar and getting out, but rather, "want to build something we can be proud of and something you can be proud of."

Emerald Isle Mayor Richard Smith ruled the developers could make their presentation, but, when asked if the town board could vote on the preliminary plat, replied, "I don't think so," because of the moratorium.

AFTER MORE discussion, however, town board member Richard Conover, one of the moratorium's strongest proponents, hinted he might be willing to compromise on the question, and asked to go into executive session to get legal advice from town attorney Richard Stanley.

When the executive session ended, Mr. Conover moved that projects already approved by the planning board be eligible for consideration by the town board. The motion passed unanimously.

PEBBLE BEACH developers then pushed for immediate consideration of their preliminary plat, asking for either conditional approval or permission to open an Emerald Isle sales office and begin pre-selling units.

Town board members then cited a number of problems they saw in the Pebble Beach proposal. Those problems included lack of state approval of the sewage disposal system, display of an incorrect water line size and lack of adequate space for fire trucks to get to the ocean side of the project's front-row buildings.

PITTMAN said the water line size had already been straightened out and pledged to add a fire lane around the buildings.

The designer of the project's sewage system said he would have preliminary state approval within 30 days. The board then told the developers to come back for consideration of the revised plans at the next board meeting.

THE MORATORIUM question itself was first posed by Mayor Smith during a special meeting last Tuesday afternoon.

The Mayor presented a six-point study program he felt the town should undertake, and board members last night agreed to his proposal. Town Commissioner Richard Conover was appointed last night to oversee comittees that will underake the following:

—A study of soil saturation and pollution levels from the town's septic tanks.

—A study of fire hazards and fire protection.

—A study of water availability and water pressure.

—A study of the town's building codes.

—A study of Emerald Isle's population density.

—An effort to convince Carteret County to lower the

density levels it allows in group housing projects so that pollution in the east end of Bogue Sound might be alleviated.

COMMISSIONERS Al Banadyga, A.B. Crew and Conover then voted for the moratorium, while commissioners Bea Pase and Walt Gaskins voted in opposition.

In a related matter, Emerald Isle Fire Chief George Foster told the board that several problems surrounding the town's ability to fight fires at the Point Emerald Condominium project had either been solved or were on the way to being solved.

CHIEF FOSTER said the developers and the private firm that supplies the town's water would try to put in a loop water system that would enable more water to be used in fighting fires, and said the developers planned to remove a meter from the water main leading to the project.

At last week's special meeting, a discussion of the potential fire hazards at Point Emerald took place.

LAST NIGHT Chief Foster praised Point Emerald's own fire safety features. He said it was one of the best.

Also last night the town board voted unanimously to overturn a planning board recommendation to deny a request by William Holz and W.B. McLean to rezone from campground to R.M.H. (residential, motel, hotel) a 10.2-acre tract of land east of and adjoining the Holiday Trav-L Park.

MR. HOLZ, representing Mr. McLean, argued that changing the zoning to R.M.H., which allows condominiums, would represent an upgrading of the zoning to a less intense use, and would drastically increase the tax value of the land.

Commissioner Conover abstained from voting, but that was considered a positive vote and the rezoning passed unanimously.

TOWN BOARD members, howevers, turned down two other rezoning requests last night. Paxon Holz, husband of William Holz, had sought to rezone, from residential to mobile home, part of a tract bounded by Holly Street and Bouge Inlet Drive.

That request, earlier given an unfavorable recommendation by the planning board, last night was turned down 5-0, as was a request by Edwin Clark to rezone a tract on Jefferson Place from R.M.H. to institutional.

Emerald Isle looks ahead

Town receives study group reports

By JEFF JONES
News-Times Staff Writer

EMERALD ISLE commissioners Tuesday night received four of five reports from citizen study committees created to help chart a future for the resort community.

Study group leaders were introduced by Commissioner Dick Conover, who serves as overall chairman of the immediate and long-range planning project.

RUSSELL BEARD, leader of the study group on soil and density, told town fathers his committee's report was incomplete.

The town only last month contracted with Henry von Oesen and Associates, a Wilmington engineering firm, to undertake a study of soil capacity to handle sewage effluent. That information would be needed to determine how many housing units per acre should be allowed in the town.

THE COMMITTEE also visited a research site at West Onslow Beach, where scientists from N.C. State University, Raleigh, are doing a long-range study on the movement of pollutants from waste water through the soil and the effects of a fluctuating water table.

In conversations with Dr. Craig Cogger, leader of the research team, the committee has received preliminary data that indicates soil there, which is similar to soil on Emerald Isle, can handle up to 18 bedrooms per acre. That would translate to nine two-bedroom housing units or six three-bedroom units per acre. Currently, the enforced limit is 10 per acre.

BUT THAT information is from conversation only. "The committee believes we need more information than a conversation before we can hang our hats on this number," Mr. Beard noted in the report.

The soil and density study group leader said he expected to receive the von Oesen study soon, but could not say when the university study might be ready. He recommended that the board continue the moratorium on group housing construction until more information is available, advice commissioners did not accept (see story on Page 5A).

EVAN RODERICK, leader of the study group on traffic flow and street patterns, told commissioners Coast Guard Road presents the most pressing problem for the town now and in the future.

He said the study group, working with Lex Kelly, highway engineer for the N.C. Department of Transportation, found heavy traffic, primarily from patrons of Holiday Trav-L-Park, compounded by the difficulty of ingress and egress from an elevated curve on Emerald Drive, has resulted in the problem.

MOREOVER, the group anticipates a worsening problem with the proposed addition of another campground nearby and the addition of two condominium projects.

The committee recommended that the entrance to Coast Guard Road from Emerald Drive be widened and that provision be made for three lanes of traffic; that Reed Drive be made one-way going east from Coast Guard Road to Islander Drive with a raised curve and pedestrian walkways for that block, creating a loop and diverting traffic leaving the campground from Coast Guard Road onto Islander Drive; that Holiday Trav-L-Park be persuaded to provide a check-in and check-out area removed from the street and the highway; that three-lane traffic should be created in high density development areas; and that Coast Guard Road be widened and realigned to eliminate sharp curves.

THAT FINAL recommendation, to widen and straighten out Coast Guard Road, would involve resurfacing and rebuilding. The expense of the project was not estimated in the report.

According to the traffic study group, the next problem the town can expect will be on Emerald Drive. The group recommended limiting access from property zoned commercial by means of parallel service roads.

THE PROBLEM lies with cars entering and exiting in the shopping area from separate businesses, instead of from intersections, thereby impeding traffic on Highway 58 (Emerald Drive).

The traffic study group recommended the town provide adequate lighting at intersections and regularly cut weeds and bushes that limit visibility.

JACK STIMPSON, leader of the study group on building codes, recommended the employment of a building department clerk, whose job it would be to man a desk in the town hall, answer questions and issue building permits.

That would free the town's two building inspectors to make thorough inspections of construction projects as they proceed. At present, they have to spend half of their time in the town hall doing what a clerk could do. The current practice was described in the report as "poor management."

THE BUILDING codes study group recommended adoption of an ordinance requiring that every job site have some kind of sanitary facility, permanent or temporary (OSHA-approved, if temporary). One facility for each 10 workmen was proposed.

The group further recommended that building permit fees, which have not been increased since 1979, be hiked by 20 percent across the board. The reason for the increase, the group reported, was a dramatic rise in the cost of inspection.

RECOMMENDED as a standard for computing permit fees was $34 per square foot of construction, all kinds, including modular as well as "stick-built" construction. That would represent an increase of $6 per square foot for standard construction and a jump of $19 per foot for modular construction. At present, the town figures fees at $28 per square foot for standard construction and $15 for modular construction.

The group recommended the addition of heating and air conditioning inspection fees, $10 per ton for combination systems (heating and air conditioning) and $3 per square foot of construction for heating systems only.

THE BUILDING codes study group recommended that the town require a plot plan showing building location be done by a certified surveyor, upon completion of footing for foundation or the driving of piles.

The group suggested the town require scale plans and specifications for any structure costing more than $3,000. That figure, the group reported, would allow a homeowner to build a deck, but not to make a room addition or larger expansion without proper forethought and consideration. "It will also mean no more 'napkin' plans," the report stated.

THERE IS A problem, the group noted, with storing construction plans, principally because there is no time limit for keeping them. So the group recommended setting a limit of one year on most construction projects, after which the owner could reclaim his plans or the town could dispose of them. The exception would be for multi-family projects, which could be kept five years or longer, the group suggested.

The group further recommended that an effort be made to inform contractors that their subcontractors, too, must purchase privilege licenses from the town, that they cannot operate as wage earners under the general contractor's permit. The penalty for refusing to comply should be a stop-work order from the building inspector, the group recommended.

FINALLY, the building codes study group suggested that the town make it mandatory, in order to receive a building permit, that contractors show proof of liability insurance coverage. Presently, there is no such requirement.

George Foster, leader of the fire and water study committee, submitted a report recommending that the town proceed with plans to bring a fourth well on line within the next year and provide two water mains throughout the town within several years.

THE FIRE and water study group further urged the town to consider the addition of a fifth well that is likely to be needed within four to five years, given the current rate of growth and the likely addition of more and more group housing projects.

The town's 950-gallon-per-minute pumping capacity and 120,000-gallon storage capacity (two 60,000-gallon elevated tanks) is adequate for current population peaks during the summer months. But domestic consumption, based on current figures, is expected to increase 10 percent in the coming year. Additional group housing projects could push that even higher.

CONTAMINATION of deep wells (100 to 200 feet or more) by septic tank effluent is not likely, according to the report. But the possibility of contamination exists for shallow wells (25 to 50 feet or more, but under 100). So the group recommended that new housing units be required to connect to the system serving the town, Bogue Banks Water and Sewer Corp., and that no shallow wells be used for human consumption.

The group also suggested that it would be wise for residents who have shallow wells to have them tested at least annually.

THE REPORT urged good cooperation among fire department representatives, developers and members of the town planning board with regard to placement of fire hydrants, especially those serving group housing projects.

Future plans for the town fire department include the addition of a substation in the eastern end of town (now under construction), acquisition of a third pumper truck as soon as possible, planning for a new primary station and the continued updating of equipment at a healthy pace.

THE FIRE and water study group recommended the addition of a limited number of paid firemen, who would serve as engineers, and the purchase of an "aerial platform-snorkel truck."

The report acknowledges that the truck would be very expensive and suggests that the town would be greatly appreciative of contributions from developers of high-rise construction that would be served by the truck. At present, the fire department is limited to a 35-foot ladder, making it impossible for firefighters to reach the roofs of many existing homes.

THE COUNTY liaison study group did not turn in a report by Tuesday, although Doug Fleming, a county commissioner who serves on the committee, was present at the meeting. He reported plans for a countywide conference on housing unit density, involving the county and each municipality, and he invited Emerald Isle to send representatives.

The overall chairman, Commissioner Conover, asked fellow members of the Emerald Isle board to review the reports in the coming weeks and be prepared to discuss them in October. He thanked all those who volunteered their time and effort in the project.

In order to follow up on work started by the study groups, the following commissioners were asked to oversee the work: Walt Gaskins, traffic flow and street patterns; Al Banadyga, building codes; A.B. Crew, fire and water; Mr. Conover, soil and density.

3-2 vote

Town ends group housing moratorium

DESPITE advice to the ontrary, Emerald Isle com-issioners voted down a mo-on Tuesday night that ould have continued the own's moratorium on group ousing projects.

Commissioners A.B. rew, Walt Gaskins and Bea ase cast votes that de-eated the motion made by ommissioner Dick Conover nd supported by board ember Al Banadyga.

THE 3-2 decision followed resentation of reports from itizen study committees reated to help the town oard map out the resort community's future, one of which had urged the board not to lift the moratorium.

The committees were asked to look at traffic flow and street patterns, building codes, fire protection and water needs, and capacity of soil on the island to handle sewage effluent, which would have a direct bearing on housing density (see separate report on committee findings, this issue).

RUSSELL Beard, leader of the latter group, called the Soil and Density Study Committee, said lifting the moratorium on group housing would negate the purpose of an $8,300 contract with Henry von Oesen and Associates, consulting engineers from Wilmington, to undertake a density study.

The moratorium may be a "temporary inconvenience for some, but the long-term benefit for Emerald Isle is of paramount importance," the committee report noted.

BUT TOWN administrator Jim Caldwell pointed out that, other than the proposed Sea Oats condominiums, there are no announced group housing projects in the offing. Following normal procedure, from preliminary to final approval of a given project, there couldn't be another in the works before December, he said.

Just prior to the vote, Commissioner Gaskins reminded board members they had been advised by more than one attorney that a moratorium would not hold up in court.

"I'M NOT in favor of condominiums springing up all over the place, but I'm not in favor of moratoriums, either," Commissioner Gaskins said.

The town board establisted the moratorium on June 8. It expired Sept. 8.

THE NEXT item on the agenda was a request for approval of Sea Oats, a proposed condominium development off Reed Drive. Developers, represented by Beaufort attorney Claud Wheatly III, assured the board that plans had been reworked to meet every requirement of an RMH (residential motel, hotel) zoning district.

Acreage had been refigured at 9.34, a third of an acre less than first shown on plans; the number of housing units had been reduced from 96 to 93; and other changes suggested by town planners and members of the board of commissioners had been made.

"WE WILL meet any reasonable requirement. Just tell us what you want us to do and we'll do it," Mr. Wheatly said. "We want this resolved. I've been here four times already."

But town fathers learned that the planning board had not yet seen the latest set of plans, and they voted 5-0 to send the request back to the planning board.

Wilmington Morning Star / Friday, November 12, 1982

Planner says cities control development

By Bernadette Hearne
Staff Writer

PINE KNOLL SHORES — If coastal residents are unhappy with the way their communities are being developed, they have only themselves and their elected officials to blame, a professional planner said.

A.C. Hall, who was Raleigh's city planner for 27 years and now guides development on Bogue Banks near Atlantic Beach, said local officials have the power to make their towns develop in any way they see fit. If development doesn't match their ideals, he said, it is because local officials don't have the foresight or courage to set goals and stick to them.

Hall was one of a dozen experts on planning and coastal issues called on this week for a symposium on condominium development in coastal areas. The symposium was jointly sponsored by Carteret County and the N.C. Office of Coastal Management.

"The title of this panel is a symptom of the problem," Hall said. "It says 'zoning and land use planning techniques.' That's completely backward. You must have the plan first, and then develop the zoning to realize the plan.

"A board must have a plan — a set of goals," he said. "First, you must decide what kind of community you want. They you have to ask yourself, 'What can we do to get that? We know whether we want buildings this high or whether we don't. We know whether open space is important to us or not.'

"Once you have your objectives, then you can design your zoning to reach those objectives. You can't take pre-set zoning and try to adapt it to your goals.

"Once you begin to administer it, your measure of success is directly proportional to the length of the backbones you have on the board," Hall said. "Anytime you have a law, you're going to make some people unhappy. If you're not going to make this guy who wants to violate your goals mad, you may as well throw the plan away."

All too often, local officials are unwilling to make the hard decisions necessary to create the communities they want, panelists agreed.

"I'm frequently asked what is the optimum density for multifamily development," planner Robert Leary said. "There is no magic figure. There are a series of ranges of intensities."

Leary encouraged coastal communities troubled by the proliferation of condominiums to investigate a concept known as the land use intensity system. Details of the system are available from the U.S. Department of Housing and Urban Development, which devised it.

"It allows you to relate intensity of development to the required open space, off-street parking, recreation space," Leary said. "It provides a range of 40 choices of intensity you can pick from based on the carrying capacities of your water and sewer and traffic facilities."

All too often, Leary said, local zoning ordinances make false promises. They permit a certain density per acre but require setbacks and off-street parking and impose height limitations that make those densities impossible to achieve, he said.

With the intensity system, Leary said, a developer has a clear idea of what is expected of his project and what he must do to meet the town's requirements. The town is protected because it has put its goals in a clear, regulatory form, he said.

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Residents can plan community

If you're like a lot of folks, you pick up your newspaper some mornings and see that somebody wants to build something in a place where you wish they wouldn't.

Maybe it's an oil refinery on the river or a shopping center in a quiet neighborhood or a tall building in a scenic area. Maybe the project will tie traffic in knots or threaten the pollution of shellfish beds or drinking water.

You shrug your shoulders. What can you do?

Plenty, if you and other people like you get together and tell public officials how you feel. But you'd better do it before you pick up the paper and see those plans. By then it's awfully late.

That was the sermon that planning experts were preaching near Morehead City last week. A dozen experts addressed a conference at Pine Knoll Shores dealing with condominiums on the coast.

A.C. Hall, who was Raleigh's planner for 27 years, summed it up: The people who live in a community can control what it becomes. But only on two conditions:

—They have to decide what they want and tell public officials what that is.

—Public officials have to have the imagination to draw up appropriate zoning and the backbone to stick to it.

This is all a bit new to most of us. Coastal North Carolina for decades was a quiet little corner of the world. We didn't have to face the problems other places did.

Now the region is being discovered by industry and tourists and refugees from the snow. That means more jobs, more prosperity, more advantages. It also means problems that are new and difficult.

It means changing some of our attitudes about land and what should be done with it.

What the planners were telling coastal residents last week is that those problems are not beyond our control.

The only question is whether we have the interest, and public officials have the nerve, to face them.

APPENDIX B

DOCUMENTATION OF SEPTIC TANK PROBLEMS

ENVIRONMENTAL HEALTH DIVISION
CARTERET COUNTY HEALTH DEPARTMENT
BEAUFORT, NORTH CAROLINA 28516

A. B. QUINN, SUPERVISOR
ENVIRONMENTAL HEALTH

(919) 728-2223

04 October 1982

Henry Von Olsen and Associates
Consulting Engineers and Planners
611 Princess Street
P. O. Drawer 2087
Wilmington, N.C. 28402

Attention: Mr. William E. Burnett

Dear Mr. Burnett:

In reply to your letter of 14 September 1982, the following information is submitted:

1. The failure rate for septic tanks on Emerald Isle is approximately 1% of those installed over the past five (5) years. These failures are primarily caused by the sewage disposal systems being utilized beyond their design capabilities. Some of the systems were designed for single family utilization, and later a duplex is added without upgrading the system to meet the additional need.

2. Many soil types are found on Emerald Isle. The most predominate soils on the ocean side are Corolla, Newhan and Newhan-Corolla Complex. These type soils are considered suitable for ground absorption on-site sewage disposal systems.

   The sound side, in many areas consists of Fripp Fine Sand. These soils are also considered suitable for ground absorption; however, along the sound side, these ridges of Fripp soils are separated by small, narrow troughs that contain either ponded water, shallow organic soils, or poorly drained mineral soils. These areas are found on the ocean side also, but not to as great extent as on the sound side. Such areas are not easily drained and filled, and would require extensive modification to be classed as suitable for ground absorption.

3. In order to fully develop Emerald Isles' potential for domestic housing and businesses, a central sewage system is essential. Large areas along the sound side cannot be used for on-site sewage disposal without extensive modification, which in many instances would render the building sites economically unsuitable. Also, in forrested areas the use of on-site sewage disposal facilities requires elimination of large areas of vegetative growth and promotes wind and water erosion. Stabilization of these soils by vegetation is vital in these very fragile environments.

Continued use of on-site sewage disposal systems on Emerald Isle will undoubtly create many future problems. Using existing septic tank technology, many wet and/or impermeable soils in the area have severe limitations. In the

dry, sandy soils, such as the dunes, the soil is too permeable to accommodate effluent, thus pollution of ground water and adjacent estuarine water is probable. Using current technology, it is difficult and expensive to overcome these limitations in a way that is not damaging to the environment.

If the economy of Emerald Isle is to continue to grow through the rapid and orderly development of its land and water resources, a means of rendering domestic sewage ecologically safe must be provided. A giant step toward this end can be taken by the installation of a central sewage system to serve all Emerald Isle. Immediate action to accomplish this is urged.

Sincerely,

A. B. Quinn
Environmental Health Supervisor

ABQ/cw

APPENDIX C

DESCRIPTIONS OF SOIL TYPES

TABLE - ESTIMATED SOILS PROPERTIES SIGNIFICANT TO ENGINEERING

MAP SYMBOL, LAND TYPES	DEPTH TO SEASONAL HIGH WATER TABLE	FLOODING	PERMEABILITY
#1 Beach, occasionally flooded	1.0 to 3.0'	Frequent (monthly)	Rapid 6.3"/hr
#2 Leon fine sand	0 to 3.0'	Some surface ponding	Rapid 6.3"/hr
#3 Beach-Foredune Association	Beach-0 to 3.0' Foredunes 6.0'	Frequent Rare	Rapid 6.3"/hr
#4 Bohicket soils, low	0 to 3.0'	Frequent (daily)	Slow 0.06"/hr
#5 Tidal Flats	0 to 3.0'	Frequent (monthly)	Rapid 6.3"/hr
#6 Carteret soils, low	0 to 3.0'	Frequent (daily)	Rapid 6.3"/hr
#7 Corolla fine sand	1.5 to 3.0'	Rare to Common-Storm tides	Very rapid 20"/hr
#8 Corolla fine sand, forested	1.5 to 3.0'	Rare-high storm tides	Very rapid 20"/hr
#9 Corolla-Duckston complex	1.0 to 3.0'	Rare to Common-Storm tides	Very rapid 20"/hr
#10 Dredge Spoil	3.0'	Rare-Storm tides	Rapid 6.3"/hr
#11 Hobonny soils	0 to 2.0'	Frequent (monthly)	Moderate 0.63 to 2.0"/hr
#12 Duckston fine sand	1.0 to 2.0'	Rare to Common Storm tides	Very rapid 20"/hr
#13 Duckston fine sand, forested	1.0 to 2.0'	Rare to Common Storm tides	Very rapid 20"/hr
#14 Duneland	6.0'	None	Very rapid 20"/hr
#15 Fripp fine sand	6.0'	Rare-storm tides	Rapid 6.3"/hr

TABLE (Con'd) ESTIMATED SOILS PROPERTIES SIGNIFICANT TO ENGINEERING			
MAP SYMBOL, LAND TYPES	DEPTH TO SEASONAL HIGH WATER TABLE	FLOODING	PERMEABILITY
#16 Levy soils	0 to 2.0'	Frequent (monthly)	Slow 0.06 - 0.2"/hr
#17 Madeland	3.0'	Rare-storm tides	Rapid 6.3"/hr
#18 Carteret soils, high	1.0 to 3.0'	Frequent (monthly)	Rapid 6.3"/hr
#19 Carteret soils	0 to 3.0'	Frequent (monthly)	Rapid 6.3"/hr
#20 Currituck soils	0 to 3.0'	Frequent (monthly)	Rapid 6.3"/hr
#21 Newhan fine sand	6.0'	None	Very rapid 20"/hr
#22 Newhan-Corolla Complex	----See ratings for individual soil----		
#23 Duneland-Newhan Complex	----See ratings for individual soil----		
#24 Newhan-Urban land complex	-----See ratings for individual soil-----		
#25 Wando fine sand	6.0'	None	Very rapid 20"/hr
#26 Conaby soils	0 to 1.0'	Surface ponding	Rapid 6.3"/hr
#27 Echaw fine sand	2.5 to 5.0'	None	Rapid 6.3"/hr
#28 Kureb fine sand	6.0'	None	Rapid 6.3"/hr
#29 Currituck soils, high	0 to 2.0'	Frequent (monthly)	Rapid 6.3"/hr
#31 Bohicket soils, high	0 to 3.0'	Frequent (daily)	Slow 0.06"/hr

TABLE - DEGREE AND KIND OF LIMITATION FOR STATED USE			
MAP SYMBOL, LAND TYPES	DWELLINGS	STREETS & ROADS	SEPTIC TANK FILTER FIELD
#1 Beach, occasionally flooded	very severe-flooding	very severe-flooding	very severe-flooding
#2 Leon fine sand	severe-high water table	severe-high water table	very severe-high water table
#3 Beach-Foredune Association	very severe-flooding	very severe-flooding	very severe-flooding
#3 Bohicket soils, low	very severe-flooding-wet	very severe-flooding-wet	very severe-flooding-wet
#5 Tidal Flats	very severe-flooding-wet	very severe-flooding-wet	very severe-flooding-wet
#6 Carteret soils, low	very severe-flooding-wet	very severe-flooding-wet	very severe-flooding-wet
#7 Corolla fine sand	severe-wet	severe-wet	severe-wet[1]
#8 Corolla fine sand, forested	severe-wet	severe-wet	severe-wet[1]
#9 Corolla-Duckston complex	severe-wet	severe-wet	severe-wet[1]
#10 Dredge Spoil	severe	severe	severe[1]
#11 Hobonny soils	very severe-flooding-wet	very severe-flooding-wet	severe-flooding-wet
#12 Duckston fine sand	severe-wet	severe-wet	severe-wet[1]
#13 Duckston fine sand, forested	severe-wet	severe-wet	severe-wet[1]
#14 Duneland	severe-unstable due to blowing sand	severe-steep slope, blowing sand	severe-unstable due to blowing sand[1]
#15 Fripp fine sand	severe-floods	moderate-floods	slight[1]

TABLE (Con'd) DEGREE AND KIND OF LIMITATION FOR STATED USE			
MAP SYMBOL, LAND TYPES	DWELLINGS	STREETS & ROADS	SEPTIC TANK FILTER FIELD
#16 Levy soils	very severe- floods, wet	very severe- floods, wet	very severe- floods, wet
#17 Madeland	severe	severe	severe[1]
#18 Carteret soils, high	very severe- flooding-wet	very severe- flooding-wet	very severe- flooding, wet
#19 Carteret soils	very severe- flooding-wet	very severe- flooding-wet	very severe- flooding-wet
#20 Currituck soils	very severe- flooding-wet	very severe- flooding-wet	very severe- flooding-wet
#21 Newhan fine sand	slight	slight	slight[1]
#22 Newhan- Corolla Complex	--------see ratings for individual soils --------		
#23 Duneland- Newhan Complex	--------see ratings for individual soils--------		
#24 Newhan-Urban land complex	--------see ratings for individual soils--------		
#25 Wando fine sand	slight	slight	slight[1]
#26 Conaby soils	very severe- floods, wet	very severe- floods, wet	very severe- floods, wet
#27 Echaw fine sand	moderate -wetness, blowing sand	moderate- wetness	severe- wetness[1]
#28 Kureb fine sand	slight	slight	slight[1]
#29 Currituck soils, high	very severe- floods, wet	very severe- floods, wet	very severe- floods, wet
#31 Bohicket soils, high	very severe- floods, wet	very severe- floods, wet	very severe- floods, wet

[1]The sandy soils are highly pervious with questionable filtering capacities. Thus, contamination of groundwater is possible.